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THESIS

DUAL-USE TECHNOLOGY AND SUSTAINMENT OF THE CHEMICAL INDUSTRIAL BASE

by

Gwendolyn O. Dingle

June 1995

Thesis Co-Advisors: Mark W. Stone
Alice Crawford

Thesis
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The changing defense acquisition process and the declining defense budget require alternative methods for sustaining unique sectors of the defense technology industrial base (DTIB) such as the chemical sector. One method is the dual-use of the technology by the producers within the base to manufacture the products required to provide Nuclear, Biological and Chemical (NBC) defensive support for the nation. As the size of the defense budget and force structure shrinks, so will the number of producers within the chemical industrial base (CIB) but the need for alternative sustainment methods will increase. The purpose of this thesis is to analyze and determine if dual-use can be applied and what benefits it offers the CIB. Successful applications of the dual-use of technology have taken place in other defense sectors. The intent of this thesis is also to analyze and review areas of successful uses in other sectors. The analysis of dual-use in the CIB was conducted by obtaining the opinions of experts in the areas of dual-use, DTIB, and CIB through interviews. This research determined that dual-use can be applied to the CIB in the areas of detection, individual protection, collective protection filtration, and biological defense. Additionally, this research identified that the dual-production (i.e., reuse or joint use) of the production facilities is as important as the dual-use of the technology. The research concludes that DoD should further promote dual-use as a means of sustaining and retaining producers in the CIB.

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DUAL-USE TECHNOLOGY AND SUSTAINMENT OF THE CHEMICAL INDUSTRIAL BASE

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ABSTRACT

The changing defense acquisition process and the declining defense budget require alternative methods for sustaining unique sectors of the defense technology industrial base (DTIB), such as the chemical sector. One method is the dual-use of the technology by the producers within the base to manufacture the products required to provide Nuclear, Biological and Chemical (NBC) defensive support for the nation. As the size of the defense budget and force structure shrinks, so will the number of producers within the chemical industrial base (CIB) but the need for alternative sustainment methods will increase. The purpose of this thesis is to analyze and determine if dual-use can be applied and what benefits it offers the CIB. Successful applications of the dual-use of technology have taken place in other defense sectors. The intent of this thesis is also to analyze and review areas of successful uses in other sectors. The analysis of dual-use in the CIB was conducted by obtaining the opinions of experts in the areas of dual-use, DTIB, and CIB through interviews. This research determined that dual-use can be applied to the CIB in the areas of detection, individual protection, collective protective filtration, and biological defense. Additionally, this research identified that the dual-production (i.e., reuse or joint use) of the production facilities is as important as the dual-use of the technology. The research concludes that DoD should further promote dual-use as a means of sustaining and retaining producers in the CIB.

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I. INTRODUCTION

The purpose of this thesis is to analyze and determine if dual-use can be used to sustain the Chemical Industrial Base (CIB) and what benefits it offers. Successful applications of the dual-use of technology have taken place in acquisition of defense systems. The intent of this thesis is also to analyze and review areas with successful uses of the dual-use technology in other sectors of the Defense Industrial Base (DIB). This introduction provides the background and objectives for this thesis. Additionally it includes a list of the research questions addressed and discusses the scope, the limitations and the assumptions made during the formulation of the thesis. A brief summary of the thesis methodology is provided and the organization of the thesis is described.

A. BACKGROUND

An American Defense Preparedness Association (ADPA) White Paper in *National Defense* provided information about the latest problem for the Department of Defense (DoD): the lack of sufficient advanced technology in the industrial base. The article also reveals that the growing deficit places more emphasis on the ability of DoD to sustain an industrial base that is technologically capable of supporting our wartime needs. (National Defense, 1993, p. 35) The DoD draw-down indicates the likelihood of decreased production in the DIB, reflected in the departure of various producers from the base. Although the reductions will have a stronger impact on the sectors of the base that have little or no commercial applications, all producers in the industrial base will experience decreases in production. (National Defense, 1993, p. 35)

The results of this industrial base decline will be more intense for lower-tier contractors that are solely dependent (at least 50 percent or more of their business) on the DoD for business. (National Defense, 1993, p. 35) The likelihood of more budget declines and draw-downs will become more visible as large defense contractors hold on to DoD productions to sustain their business base. The larger defense contractors, by retaining productions for themselves, will propel the effects of the defense draw-downs to the lower-level contractors. These effects will worsen as prospects of more budget declines make their way through the smaller sectors of the industrial base. The large defense contractors view DoD contracts as a means to retain their viability in the base.

There are many concerns in the DoD and the commercial world about the survival of the industrial base. The concerns focus on access to advanced technology by defense contractors due to the traditional emphasis of the base on defense-specific systems and technologies.

The ADPA White Paper, previously mentioned, stated that the bulk of U.S. manufacturers are small businesses that comprise the majority of the U.S. production base. This reveals that subcontractors are really the life line for the nation's wartime industrial support. Considering this information, the DoD stands to lose much of its industrial support if it fails to make provisions that will allow sustainment of the small sectors of the industrial base. (National Defense, 1993, p. 37)

Small companies are unable to expand and keep pace with the advances in technology that larger defense companies can achieve due to insufficient funding and capability. (National Defense, 1993, p. 37) This deficiency worsens when smaller, more discrete sectors of the base, like the chemical sector, are explored.

There is a very limited number of manufacturers in the industrial base with a capability to produce the chemical equipment that provides chemical defensive support for the U.S. armed forces. These manufacturers already face the challenge of small and limited procurements with limited budget dollars. The challenges grow because the force structure's draw-down will further reduce the number of procurements and potential contractors. It is because the CIB producers may in some instances "lack experience and specialized knowledge to shift to commercial production and compete successfully in commercial markets" that there may be a tremendous dual-use potential. The potential exists because to use the knowledge and technology gained in defense productions allows

CIB producers to gain the experience and knowledge for commercial efforts. (GAO Report, 1993, p. 4)

The CIB is the sector of the DIB composed of small and large defense contractors that produce a variety of Chemical Defensive Equipment (CDE). This CDE provides the defensive protection of the nation's Armed Services against Nuclear, Biological, and Chemical (NBC) agents in war. These producers are uniquely different from the other sectors of the industrial base primarily due to their large reliance on DoD for work because there is little commercial use for the specialized equipment produced. The equipment in Table I are the typical items manufactured by CIB producers.

TABLE I: Equipment Manufactured by CIB Producers

Equipment Category	*Item*
Individual Protection	Battle Dress Overgarments Protective Mask
Chemical Detection	Automatic Chemical Agent Alarm M21 Remote Sensing Chemical Agent Alarm Chemical Agent Monitor (CAM)
Collective Protection	Simplified Collective Protection (SCPE) M48 Filter Unit Modular Collective Protection Equipment (MCPE)

Source: (CBDCOM, 1994, pp. A-2-1 - A-2-6)

The U.S. Army Chemical and Biological Defense Command (CBDCOM) conducted a CIB sector study for the Joint Logistics Commanders (JLC). This study assessed the overall health of the CIB and found the CIB sector was "stable" but required continuous monitoring. (CBDCOM, 1994, p. 45)[1] The monitoring ensures resolution of the deficiencies when reasonably possible.

> Some experts have predicted that barring a national emergency defense spending could drop below $200 billion--again in constant 1994 dollars--by the turn of the century, a level not seen since 1940. (Kitfield, 1993, p. 18)

---

[1] Chapter II provides further information on the CBDCOM study results.

The prospects of such a declining budget combined with reductions in subcontracting are all the more reason why dual-use would be wise for the defense department. Dual-use is an avenue for DoD to have a minimum number of qualified producers in the industrial base to produce weapons and support systems for wartime needs. The benefits of having more than one qualified producer or manufacturer are: "quick logistic response, reduction of long production lead times, and reduction of technology cost and schedule risks." (McIlvaine, 1994, p.32) An additional benefit is long term business for the producer.

A 1993 General Accounting Office (GAO) report indicated that the National Defense Authorization Act for Fiscal Year (FY) 1991 required DoD to provide an annual report to Congress on the viability of the DIB. The report further revealed that DoD felt that:

> ...Their ability to meet future national security needs will depend on the ability of individual companies to shift from defense to commercial production as required. This statement clearly indicates that DoD realizes the importance of dual-use technology. It also indicates DoD's openness to the actions required to provide an opportunity to sustain the DIB. (GAO, 1993, p. 3)

The dual-use of technology[2] permits contractors to use the technology gained from military procurements in commercial applications. The 9mm Beretta family of pistols is a successful example of the application of the dual-use technology concept. The civilian and military law enforcement officials along with special operations forces use the weapon. The dual-use benefit of this weapon is that production for both versions occurs at the same time on the same production line (McIlvaine, 1994, pp. 33-34).

Dual-use technology's application to the CIB will allow producers to improve their capability to succeed in the commercial sector and decrease their reliance on defense contracts. The improved contractor potential will also provide the technological edge the nation's industrial base needs for support in time of war.

---

[2] Chapter II provides further information on dual-use technology and DoD's policies.

B. OBJECTIVES

The objective of this thesis is to conduct an analysis of dual-use technology for the sustainment of the contractors and subcontractors in the CIB. Another objective of this research is to determine the desirability within DoD to use this concept to sustain the CIB. Following this determination, this thesis discusses the effective use of dual-use and the disadvantages and advantages of this application. Finally, this thesis provides recommendations of areas of further study for the U.S. Army and the DoD to consider regarding dual-use technology and the CIB.

This topic is important to the Army and DoD because it offers the potential to:

- Allow sustainment of the CIB.
- Allow the Government to gain a technological edge.
- Reduce the cost, schedule and performance risks for the Government and contractors.
- Ensure that sufficient weapon systems and support items are available to support the national defense objectives.

C. RESEARCH QUESTIONS

1. Primary Research Question

The primary research question to be answered within this thesis is: What are the benefits of using the concept of dual-use technology to sustain the CIB?

2. Subsidiary Research Questions

The subsidiary research questions to be answered within this thesis are:

- What is the CIB?
- What types of industries make up this CIB?
- What makes the Chemical sector unique from other sectors of the DIB?
- Does the current situation of the Department of Defense budget and downsizing require the application of dual-use technology?

- What is dual-use technology and how does it relate to the DIB?
- What are DoD's goals and objectives concerning dual-use technology?
- How can dual-use technology be applied to the CIB?
- What are the advantages of dual-use technology to the CIB?
- What are the disadvantages of dual-use technology to the CIB?

D. SCOPE, LIMITATIONS AND ASSUMPTION

1. Scope

The Army's use of dual-use technology in acquisition programs mentioned earlier in this chapter provides evidence that dual-use is successful in accomplishing a lower unit cost, quicker fielding availability and viability for the contractor. The Army and DoD must make efforts to develop dual-use capability in all sectors of the DIB. This thesis discusses how the application of dual-use technology in the production of CDE in the CIB can sustain the base.

This thesis reviews dual-use technology policy and how it has been implemented in other areas of the DoD. The thesis draws on these experiences to addresses dual-use application to the CIB.

2. Limitations and Assumptions

This research is limited to the CDE section of producers in the DIB. The researcher assumes: (1) the reader has a general knowledge of the DIB, CIB and dual-use technology, (2) that policies regarding dual-use are valid, and (3) there are no current applications of dual-use technology in the CIB. Another limitation of doing research on the potential for applying dual-use to the CIB is that the term "dual-use" is relatively new to DoD. To date no research has been done on the application of dual-use to the Defense Industrial Base.

E. METHODOLOGY

The basis for this research is current literature, regulations, acquisition documents, and interviews. The data collected from the interviews are presented in Chapter IV.

F. ORGANIZATION OF THE STUDY

Chapter I presented the introduction with the basic research questions, scope, limitations and assumptions.

Chapter II presents background information on the DIB, CIB and DoD's policy on dual-use technology. This chapter also provides a description of some of the programs the Government uses for investments in technology. Additionally, the methods available to capture and maintain critical technology and processes will also be discussed.

Chapter III describes the methodology for conducting the research and the background for the interview.

Chapter IV provides the findings and results. This chapter also discusses the advantages and disadvantages of applying dual-use technology to the CIB.

Chapter V addresses conclusions and recommendations on dual-use technology and sustainment of the CIB. This chapter also provides recommended areas for further study.

II. BACKGROUND AND LITERATURE REVIEW

A. INTRODUCTION

This chapter defines and discusses the Defense Technology Industrial Base[3] (DTIB), its history makeup, problems and deterioration. It also discusses the Chemical Industrial Base, and its make up, reasons for its existence and why dual-use is applicable. Additionally, this chapter defines and discusses dual-use technology and DoD policy regarding technology developed for defense purposes that can also be used in commercial markets. This chapter further discusses any implementation of dual-use efforts thus far within DoD related to the sustainment of the DTIB.

B. DEFENSE INDUSTRIAL BASE

1. Definition

A General Accounting Office (GAO) report on the Defense Industrial Base defines the defense technology industrial base as:

> The combination of people, institutions, technological know-how, and facilities used to design, develop, manufacture, and maintain the weapons and supporting defense equipment needed to meet U.S. national security objectives. This base has three broad components: research and development, production, and maintenance and repair, each of which includes public and private sector employed facilities. (GAO, 1993, p. 1)

2. History

The defense industrial base was initially designed to support the nation in the event of a global war similar to World War II, the Korean Conflict and the Vietnam Conflict. These were wars of extended time periods. (Thomas, 1992, p. 3) The support required for the nation's armed forces for recent crises and events such as Grenada and Operation Desert Storm (ODS) have not been the of the same extended nature and did not require the same DIB support. These recent crises required the action of quick response forces. Typically, quick response forces respond to events of limited duration. The DTIB requirements needed to support an extended duration war rather than a short duration war are notably different. (Thomas, 1992, p. 3) This difference was demonstrated in the war with Iraq.

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[3] Defense Industrial Base and Defense Technology Industrial Base are used synonomously. The "technology" aspect reflects the importance of technology to sustaining a base capable of advancing and supporting the future Armed forces.

The war with Iraq provided evidence that even though the industrial stocks of the nation were readily available, there still may be some difficulty providing the support needed for short duration wars. (Thomas, 1992, p. 3) Many ODS after-action reports (AAR) highlighted difficulties that was encountered by industrial base producers to meet surge capacity. The surge capacity of a defense producer refers to:

> The ability of the defense industry to expand military production in a "peacetime" situation, and without a formal declaration of a national emergency. The term is usually used in the context of a rapid increase in the production of key combat items in response to an emergency falling short of a declared war. Since the elements of surge are operating in a peacetime situation, defense production would be carried on for the most part by existing contractors. (Porter, 1992, p. 4)

The difficulties noted in ODS resulted because it was difficult for contracts to be awarded and for contractors to establish production lines in a timely manner. Time is required for contractors to set up their production lines and ramp up the production to their surge capacities in time to meet the requirements of a short lived conflict like ODS.

3. Composition of the base

Mr. Jacques Gansler is a well respected and noted expert on the DIB. Mr. Gansler has served on various task forces and panels on the DIB. Gansler, in his book on *Affording Defense, 1989,* describes the defense industry as being composed of three dimensions. He describes these dimensions as:

> In one dimension, the large prime contractors or weapon suppliers (normally known as "the defense contractors") are at the top, the second tier is made up of the major subcontractors (many of whom manufacture electronic devices, such as computers and radars), and the lowest tier is made of the suppliers of parts and material. It is in these lowest tiers (the level of the semiconductor producers, the metals' fabricators, etc.) that a great deal of commonality exists between the defense industry and the rest of the economy. This is often referred to as the "dual-use" tier of the defense industry, and emphasis should be placed on the desirability of increasing the use of commercial firms for defense work at this level.
>
> The second dimension is made up of the numerous distinct major sectors of the defense industry (aerospace, shipbuilding, munitions, and so on), there are dramatic differences between these sectors--for example, building ships is somewhat like building houses (i.e., one-by-one production process), while making bullets is a mass-production operation. Therefore, the Department of Defense should deal differently with each sector, and the incentives for the various sectors should differ correspondingly.
>
> The third dimension shows that the defense industry has a mixture of private ownership, and public ownership, varying significantly from sector to sector.... Again, this difference should be recognized by the DoD when it is dealing with any defense firm or sector.... (Gansler, 1989, p. 239-240)

These dimensions are important because they provide a framework of what the DIB is comprised of and where opportunities for dual-use exist. The dimensions Gansler speaks of comprise the physical makeup of the DIB. This makeup, according to Gansler, is one of the reasons for some of the problems now being experienced in the DIB. These problems include the decline of defense contracts and of contractors entering into the defense market. This decline is coupled with the inability of contractors in the base, despite advanced mobilization planning, to adequately support the nation's wartime needs. The industrial base could cease to exist if DoD does not change the way it does business with the producers and suppliers in the base. (Gansler, 1989, p. 240) The DoD way of doing business has been that all procurements must be competitive. This strong preference for competition discouraged establishment of long term customer-supplier relationships.

4. Problems

Another reason the defense industrial base is facing trouble may be due to the false ideas generated by the agencies[4] responsible for monitoring and assessing the health of the base. These agencies felt that the economics of supply and demand will bring the defense industry into balance. This scenario is unlikely because the Defense Department is not a true market. The Defense Department exists or functions in what is called by many economists as a "monosponsy." In a monosponsy, there is only one buyer of Government equipment, supplies, and services but there are many potential suppliers. This monosponsy situation has caused some firms to become solely reliant on the Defense Department as their source of revenue.

The Defense Department now realizes that in order to resolve the problems of dependency caused by this situation, the DoD must change the ways in which it does business with defense contractors. The traditional defense contractor will be forced to capture whatever share of the commercial market it can in order to be self-sustaining. The Government must now face the realization that they too will have to either accept or modify the products available in the commercial market place to suit their needs. This is a 180 degree difference from the current mentality in the Government. This mentality is to design and develop defense-unique items to meet these needs. The business as usual attitude can be no more. (Gansler, 1989, p. 243)

In 1988, the DoD's concern about the health and viability of the industrial base prompted it to task the Logistics Management Institute (LMI) to conduct a study of the base. The objective of this study was to determine what industries were most important to the DTIB. The LMI study was to be a quick assessment of the industries important to the DTIB. The study also focused on determining why the production capacity and productivity of the base were decreasing. The LMI study conducted the assessment of the industrial base using six economic indicators. These indicators were:

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[4] "DoD identified several Government agencies that have an important role in identifying and maintaining the defense industrial base: DoD, the Departments of Energy, Interior, Commerce, and the Treasury, the Federal Emergency Management Agency (FEMA) and the Office of the U.S. Trade Representative. (GAO, 1988, p. 3)"

- Import share of domestic market,
- Growth in capacity
- Growth in shipment
- Capital expenditure as expressed as a ratio to industry shipments,
- Productivity in growth, and
- Profitability (GAO, 1988, p. 22)

These indicators chosen by LMI were considered by the personnel conducting the study to be reasonable measures of performance that provide the information required by DoD. (GAO, 1988, p. 6)

The LMI study results identified 215 industries as being important to the DTIB, and found that there were some characteristics that existed among commercial industries in general that were also important to the DTIB. In general, industries important to the DIB were able to maintain a share of the U.S. market in their area of expertise. These commercial industries exhibited characteristics such as less than average growth, productivity, and investments in facilities and equipment. (GAO, 1988, p. 15) Because the study was conducted in such a quick fashion, its results were questioned by Congress and prompted a GAO review. (GAO, 1988, p. 1)

The GAO conducted a review of the study done by LMI later in 1988. The GAO review was to look at what actions DoD had taken to identify industries important to defense and what percentage of DoD contracts were being awarded to foreign contractors. (GAO, 1988, p. 1)

The GAO review of the LMI study focused on four important areas:

- Identifying the federal agencies that play a significant role in maintaining the defense industrial base and strengthening industries deemed critical to national security,

- Summarizing these agencies' efforts to identify defense-critical industries,

- Determining the agencies' actions and proposals to enhance or maintain the viability of defense-critical industries.

- Obtaining DoD's and other agencies' views regarding selected industries. (GAO, 1988, p. 1)

The GAO criticized the LMI study for inadequately defining a defense-critical industry. (GAO, 1988, p. 5) The GAO further criticized the LMI study for not considering the defense industries' "research and development (R&D) budget growth and international market share" as measures of performance. LMI personnel that conducted the study agreed with GAO in this respect and stated that due to the insufficient time allocated for the study they did not consider all measures of performance. Based on GAO's comments, the DoD concluded that the methodology used by LMI needed some refinement in order to accurately portray the problems (described above as study characteristics) in each sector of the industrial base. The DoD further determined that an analysis of each sector of the industrial base should be done. This final determination for assessments in each particular sector of the DTIB led to a number of follow-on evaluations. (GAO, 1988, p. 18)

The LMI study was only the tip of the iceberg. More research and studies were conducted on the health of the industrial base and what was needed to revive the base. In fact, research conducted in a 1992 study on the "Extinction of the Industrial Base" provided a vision of the industrial base of the future. (Thomas, 1992, p. 4) This study revealed that the mission-tailored-forces supported by the DTIB is one of the reasons the base must change. The Office of Technology Assessment (OTA) which is the analytical arm of Congress, also conducted a study on the DTIB. The OTA study revealed a set of characteristics that may likely be possessed by the future forces of the nation. Table II shows these unique characteristics. The characteristics are important because they show that the changes in the forces and the supporting infrastructure are so closely related that changes in one have a tremendous impact on the other. (U.S. Congress, 1991, p. 484-485)

TABLE II: Traits of Future Defense Forces and the supporting Industrial Base

Characteristics of Future U.S. Forces	Desirable Characteristics of the Future Base
• Smaller active and ready reserve forces	• Advanced research and development capability
• Less forward basing, greater strategic mobility	• Ready access to civilian technology
• Continuing weapons performance advantage	• Continuous design and prototyping capability
• Substantial nuclear capability	• Limited, efficient peacetime engineering and production capabilities in key defense sectors
• Chemical and biological defense capabilities	• Responsive production of ammunition, spares, and consumables for theater conflict
• Greater dependence on mobilization	• Healthy, mobilizable civilian production capacity
	• Good, integrated management

Source: U.S. Congress, House, 1991, p. 484-485.

The definition of the DTIB clearly takes into account that the industrial base encompasses more than just production and support. Technology is a very crucial, if not one of the most important elements of the industrial base. The importance of technology has grown more since the fall of the Berlin Wall. (Gansler, 1989, p. 241) This new focus on technology has pushed DoD into a situation where decisions involving unaffordable tradeoffs were being made. An example of such a tradeoff involves a decision by DoD to spend more money procuring a system because of the technology it offered. This focus for the latest technology drives the decision toward designing a new system that incorporates this state-of-the-art technology. This method of system acquisition is preferred to conducting thorough market research that would permit procurement of a commercial system that is readily available and incorporates this technology. (Gansler, 1989, p. 241) Because of such tradeoffs, the ability of the DoD to provide the necessary funds to buy and support the technology needed to maintain a viable industrial base is now questionable.

The ability of DoD to acquire the necessary funds have been shown in several reports and studies. These reports and studies indicate that:

> The President's fiscal year 1993 budget called for a $50 billion reduction in U.S. defense budget authority over the next 5 years and deeper cuts are expected from the new administration. (GAO, 1993, p. 1)

This trend has also been reflected in the Presidents fiscal year 1994 budget request. In his 1994 budget, the President requested:

> Budget authority of $263.4 billion for the National Defense budget function for fiscal year 1994.... The committee recommends an overall level of $262.8 billion in budget authority. This amount is a reduction of approximately $60 million from the amount requested by the President. (U.S. Congress, 1994, p. 2)

This decrease in the defense budget authority is repeated in the FY 1995 budget. In his 1995 budget, the President requested "$263.7 billion for National Defense" the budget authority for FY 1995 was decreased by $900 million. (U.S. Congress, 1995, p. 2)

These trends serve as indicators pointing to decline of the industrial base and loss of its capability to support the nation's national security needs. This decline is further evidenced by the fact that the commercial industries in the defense sector are no longer the leaders in advanced technology. (Allison, 1992, p. 125) Graham Allison, the author of "Rethinking America's Security" discusses how defense industries that were once the leaders in technology innovation in the early 1950s grew comfortable and complacent with this lead and lost focus on the commercial requirements necessary to maintain the technological innovation. Their loss of focus also caused the U.S. to lose focus on the commercial requirements necessary to maintain their technological innovation. This lost focus resulted in the U.S. commercial industries allowing their international counterparts to gain the lead in technological innovation. This placed the U.S. in a position well behind in some key technological areas such as those depicted in Table III. In addition to being behind, the U.S. has totally lost its foothold in other key technology areas to their international counterparts. The areas that the U.S. has lost are listed in Table IV. (Allison, 1992, p. 125-128)

TABLE III: Technologies in which the United States is WEAK

Materials and Associated Processing Technologies	Engineering and Production Technologies	Electronic Components	Powertrain and Propulsion
Advanced Metals	Design for Manufacturing	Actuators	High Fuel Economy/Power Density Engines
Membranes	Design of Manufacturing Process	Electro Photography	
Precision Coating	Flexible Manufacturing	Electrostatics	
	High-Speed Machining	Laser Devices	
	Integration of Research, Design, and Manufacturing	Photonics	
	Leading-Edge Scientific Instruments		
	Precision Bearings		
	Precision Machining and Forming		
	Total Quality Management		

Source: Council on Competitiveness (Allison, 1992, p. 127)

TABLE IV: Technologies in which the United States Is Losing Badly or Has Lost

Materials and Associated Processing Technologies	Engineering and Production Technologies	Electronic Components
Display Materials	Integrated Circuit Fabrication and Test Equipment	Electroluminescent Displays
Electronic Ceramics	Robotics and Automated Equipment	Liquid Crystal Displays
Electronic Packaging Materials		Memory Chips
Gallium Arsenide		Multichip Packaging Systems
Silicon		Optical Information Storage
Structural Ceramics		Plasma and Vacuum Fluorescent Displays
		Printed Circuit Board Technology

Source: Council on Competitiveness (Allison, 1992, p. 128)

President Clinton's National Security Strategy (NSS) indicates the importance of technology to a nation's competitive edge that is gained through its investment in technology will have a definite impact on the national security of the nation. The Clinton Administration clearly supports the need for the nation to be strong in technology and maintain a strong economy, military and a strong international political position. (The White House, 1994, p. 5)

The U.S., in spite of its weaknesses and losses in some key technological areas, still maintains strength in its technology base. This strength results from the technological lead our commercial industry has gained over the defense industry. (U.S. Congress, 1991, p. 45)

The lead attained by the commercial industry is due to declines in the DoD budget and the ability of the commercial industries to capture a portion of the international market. The desire to attain a share of the international market forced commercial industries to devote large investments to their research and development programs to gain advanced technologies at reasonable cost. The commercial market is profit driven whereas the defense market is performance driven. The advanced technology being developed in the commercial market is being done without any investment support from the Government. This independent development does not give the Government access to this technology nor any influence over how this technology is used. (Defense Science Board, 1990, p. 3-1)

5. *Reasons for problems*

The DoD is losing its ability to manage the industrial base that supports the nation's peace and war time operations. This loss occurred because of the laws, rules and regulations that require compliance by defense contractors, which are restrictive. These measures, combined with the declines in the defense budget all have an impact on the health of the industrial base. These impacts have different effects depending on the size of the contractor and the sector of the industrial base in which he provides support. (Gansler, 1989, p. 241) Large defense contractors like General Dynamics and Lockheed are in a better position to retain their defense business viability because they are at the top level or dimension of the defense industry. (Gansler, 1989, p. 239)

Typically, large contractors separate their defense operations from their commercial operations. This is primarily due to the strict rules, regulations and recordkeeping requirements placed on contractor's doing business with DoD. Small businesses usually cannot afford to separate their defense and commercial contract efforts. This forces them to focus on defense only or commercial only efforts. If they choose defense they usually are providing industrial base support in an area that is DoD specific. Often, the goods and services provided by small businesses to DoD have little or no commercial application. (National Defense, 1993, p. 9)

This lack of commercial use also applies to large DoD contractors. The Defense Department has actively taken part in measures to help sustain the larger contractor simply because of his part in the production of major weapon systems. These measures include providing for teaming ventures among large defense contractors. These ventures have the appearance of "skirting the laws that allow mergers and acquisitions among the large corporations." (Gansler, 1989, p. 258)

In the past, little attention has been given to the lower tier contractor. Even though, the lower tier contractor may provide the bulk of the contract requirements. In some instances these lower tier contractors may be supplying 60 to 80 percent of the parts and materials in support of the large contractor. Much of the expertise and the capability of the advanced technology lies with the lower tier contractors. This is because the smaller, lower level contractors are able to concentrate their efforts in a specific area and become experts in this technology. This specialization does not permit the small companies to segregate their defense and commercial business. This lost opportunity increases the reliance on DoD for their business base and viability. (Gansler, 1989, p. 258)

The Defense Department's lack of action for sustaining lower tier contractors has probably been a mistake. The mistake is made because little consideration is given to the significant role played by lower tier contractors in meeting the defense needs. The rationale that has been used by DoD has probably been that if DoD takes care of the large defense contractors these contractors will take care of their lower tier contractors. While it may have been done in some instances, the majority of large defense contractors, in this time of reductions, are unable to help anyone until they first help themselves. (Gansler, 1989, p. 258)

Unfortunately, this situation will only worsen as the defense purse shrinks. The shrinking defense purse will also shrink opportunities for the lower tier contractors as the large contractors become less inclined to subcontract work that they need to keep people employed or factories open. (Gansler, 1989, p. 258)

The importance of lower tier contractors and their competitiveness was somewhat addressed in a GAO report on "*The Adequacy of Information on the Industrial Base*." The GAO concluded that the lower tier contractors will likely bear the brunt of the decline in industrial competitiveness. The GAO also found that the management of the industrial base by the DoD has been less than optimal due to the lack of a database management system (DBMS). The DBMS is a computerized system that allows personnel to collect data and compile a database that can be used to manage files, records, stocks, etc. A DBMS permits DoD an opportunity to maintain the "pulse" of the industrial base stocks. The report stated that it is virtually impossible for DoD or any other agency with some responsibility for maintaining the health of the industrial base to access this information in one consolidated area. (GAO, 1990, p. 2)

If the health of the industrial base is going to improve, DoD must make changes to the way it conducts business with all defense contractors. The current acquisition reform and the preferences for performance and commercial specifications rather than the military specifications are a step in the right direction. All contractors that provide subcontractor support to DoD will become more important with the use of performance and commercial specifications because of the importance of subcontractors support in the industrial base.

B. CHEMICAL INDUSTRIAL BASE

1. Background

The fall of the Berlin Wall in conjunction with the demise of the Soviet Union, along with the dismantling of their chemical and nuclear weapons arsenal caused some key players in the Defense Department and Congress to question whether there was a need for any continued support of limited offensive or defensive Nuclear, Biological and Chemical (NBC) support for the nation's armed forces. The invasion of Kuwait by Suddam Hussein and the fear that some of the Soviet Union's arsenal of chemical weapons could be used by a dictatorial ruler who had used these agents against the people of his nation, quickly dispelled this doubt. The Bottom-Up Review (BUR) and President Clinton's NSS clearly indicates that the protection of the nation's armed forces against these weapons of mass destruction is a national security objective. (The White House, 1994, p. 33)

Since the fall of the Soviet Union the U.S. has changed its doctrine and tactics. The BUR and the Clinton NSS state that the nation will probably be involved in conflicts with much smaller countries. With these smaller countries there will be little or no warning and the U.S. armed forces must be prepared to respond to nearly simultaneous major regional contingencies (MRC). (Office of Secretary of Defense, 1993, p. 10) The projections are that these conflicts will most likely involve Third World countries. In light of the Gulf War, it is likely that the U.S. armed forces will be involved in both peacekeeping and counter-terrorism operations.

A review of the Gulf War requirements for chemical defensive support by the House Armed Services Committee (HASC) determined that the likelihood of the U.S. military involvement in a chemical or biological attack has dramatically increased. This increase occurred because the fall of the Soviet empire provided a false sense of security that all of our worries concerning weapons of mass destruction had been put to rest. No one ever envisioned a small third world country like Iraq would dare to strike out against the mighty Americans or any of its allies. The Gulf War made this a reality and thereby increased the likelihood of chemical and biological threats to the U.S. (U.S. Congress, 1993, p. 338) The defensive support for U.S. armed forces against nuclear, biological and chemical (NBC) threats is provided by the CIB.

2. Definition, make-up and composition

The Chemical Industrial Base is one of the major sectors of the Defense Technology Industrial Base. This sector produces defensive chemical equipment and supplies required to support the U.S. armed forces in the event of an offensive chemical attack. This sector of the DTIB is comprised of approximately 40 contractors domestic and foreign. Table V provides a listing of the chemical industrial base contractors and the critical chemical defensive equipment (CDE) technology area the contractor supports.

TABLE V: Chemical Industrial Base Contractor's and Critical Technologies

Chemical Defensive Equipment Item	Critical Technology	Contractor	Firm Size	Domestic/ Foreign	Percent Reliance on DoD
M8A1 Automatic Chemical Agent Alarm	Flow rate indicating meter	Brunswick Corp	Medium	Domestic	<50 %
Individual Chemical Agent Detector	Miniaturization technology in both the detection and electronic modules	Environmental Technologies Group. LTD (ETGI)	Small	Domestic	>50%
Chemical Agent Monitor	Printed circuit board, radioactive source, Ni-63, lithium battery	ETGI, Inc	Small	Domestic	>50%
M93 Fox NBC Reconnaissance System (NBCRS)	Integration of U.S parts into German chassis	General Dynamics	Large	Domestic and Foreign	>50%
BA 5800 Lithium Battery for CAM	Non-commercial lithium battery		Small	Domestic	>50%
Voice Communication Adapter	Miniaturization of microphone and audio equipment				
Chemical Protective Overgarment	Anti-gas cloth UK/SC/3346	Remploy. LTD (UK)	Small	Foreign	<50%
CB Protective Overgarment (Saratoga)	Textile manufacture of filter fabric-carbon spheres	Golden Manufacturing	Medium	Domestic	<50%
Chemical Protective Undercoverall	Anti-gas cloth UK	None currently			
M20A1/M28 Simplified Collective Protection Equipment	Polyethylene liner, hermetically sealed filter canisters	Mil-Spec Manufacturing	Small	Domestic	>50%
M13A1 and M8A3 Filter Units, Gas Particulate (GP)	Electronics, Carbon impregnating	Industrial Design Labs (IDE)	Small	Domestic	>50%
Modular Collective Protection Equipment (CPE) Filter Units, GP	Electronics, carbon impregnating	IDE Donaldson Company	Small Small	Domestic Domestic	>50% >50%
Shipboard Filters	Electronics, carbon filing and impregnation	Donaldson Company IDE	Small Small	Domestic Domestic	>50% >50%
Decontamination Kit, Skin, M291	XE-55 resin powder	Rohm & Haas Company	Small	Domestic	>50%
Decontamination kit, Equipment, M295	XE-55 resin powder battery	Rohm & Hass Company Truetech	Small	Domestic	>50%

Source: CBDCOM, 1994, pp. D-1 - D19.

Interest in technology has heightened world wide. This is primarily because many countries realize the potential for cost savings and benefits (i.e., short fielding times) that advanced technology offers. This world wide or global interest in advanced technology has also made it easier for terrorists to get their hands on the technological know-how to make weapons of mass destruction. The NBC defense community has continually referred to chemical and biological weapons as the "poor man's nuke." This means that chemical and biological weapons do not necessarily require advanced technology to manufacture, yet they possess a destructive power on a scale similar to nuclear weapons. To make chemical or biological weapons a producer would only require access to a facility that manufactured pesticides and fertilizers. The realization of the potential for a facility to be used for more than one manufacturing product is probable. (McIlvaine, 1994, p. 33)

The increased threat from weapons of mass destruction sparked Congress to initiate a special investigation to determine what improvements were needed to expand the support capacity within the U.S. Chemical and Biological Defensive program to counter possible terrorist attacks. (U.S. Congress, 1993, p. 340-341)

The DoD in a 1993 report to Congress on the industrial base identified a "need to maintain a warm industrial base for mobilization surge." The report referred to CDE items that were critical to the war needs and as such were obtained with additional appropriations. The "war stoppers" were items identified in a study on the industrial base by the Defense Logistic Agency (DLA). The DLA study determined two specific items of CDE as being in danger. These items were the chemical protective suit, commonly referred to as the battle dress overgarment (BDO) and the chemical protective gloves. These items were singled out primarily due to the instability of production and the lack of producers. (U.S. Congress, 1993, p. 342)

Following the Gulf War, the House Armed Services Committee (HASC) stated that the probability of an NBC attack is still very real. The HASC determined that it is important that the U.S. have the capability to protect and sustain its soldiers at a level that will allow them to continue to operate even during threat of an NBC attack. They further determined that the best way for the U.S. to counter such a threat was to establish a chemical defense program that will allow the U.S. to build-up their planning for contingency missions. This planning includes "training, detection and protective equipment, and medical prophylaxis, therapy and casualty care." (U.S. Congress, 1993, p. 340)

The HASC has given tremendous accolades to the U.S. chemical defensive programs efforts during ODS but stated that this revised program will concentrate more on the following areas:

> (1) Research, development, and acquisition - Research, development, and acquisition programs for chemical and biological detectors, protective equipment, and medical prophylaxis and treatment must be better integrated and coordinated among U.S. armed forces and with U.S. allies.
>
> (2) Management - The Department of Defense needs to strengthen the role of the Army as executive agent for the chemical-biological defense program and provided the Army the funding and the authority to execute

this mission. The Army must be held responsible for managing the entire program for all the services, and the other services must be held accountable for following the Army's direction. Joint service coordination of the program must be improved and executive oversight of the program by the Office of the Secretary of Defense should be increased. The role of the deputy Assistant to the Secretary of Defense (Chemical Matters) as focal point for the entire chemical-biological defenses program (including both physical and medical defense programs) should be strengthened, and this office perform more detailed oversight of the program and participate to a greater degree in its development. The committee recommends placing the entire Chemical-Biological Defense Program under Defense Acquisition Board oversight.

(3) Training

(a) Institutional training - Training of U.S. chemical-biological defense specialists for the Army, Navy, Air Force, and Marines should be consolidated at the Army's Chemical School. Further expansion of cooperative training programs with U.S. allies at the Chemical School should be considered. The United States should offer these facilities and other facilities associated with the chemical demilitarization program for the training of Chemical Weapons Convention inspectors.

(b) Unit training - Unit training standards for chemical--biological defense must become an integral part of unit training requirements. Unit proficiency, readiness, and capability for combat operations under the threat of chemical or biological attack should be evaluated using realistic scenarios in exercise at major training facilities and the National and Joint Training Centers.

(4) Readiness - The military services and major commanders in the field currently lack a means of tracking the state of unit readiness and training in chemical-biological defense. Unit proficiency in chemical and biological defense must become an integral part of readiness evaluation and reporting for all U.S. armed forces.

(5) Emergency planning - The potential for [dual-use] of commercial chemical facilities by a chemical weapons program and of civilian pharmaceutical and medical research and production facilities by a biological weapons program, the relative ease with which undeclared stocks and covert production or transport may be concealed, and the efforts nations will take to protect sensitive defense and proprietary

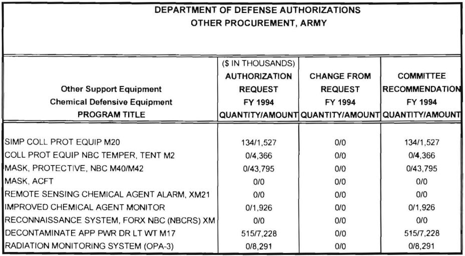
> commercial information demand continuing emphasis by the U.S. intelligence community on active intelligence programs for detection and monitoring of chemical and biological weapons programs. (U.S. Congress, 1993, pp. 341-342)

The HASC's awareness of the importance of the chemical defensive posture of the U.S. armed forces is evidenced by their actions to reemphasize the designation of the lead agency for chemical defensive matters. (U.S. Congress, 1993, p. 340)

Section 1101 of the National Defense Authorization Act for Fiscal Year 1994 (NDAA), states:

> The Army [is] the executive agent for Chemical and Biological Warfare Defense Programs. This section would provide for designation of the Army as DoD executive agent for research, development, and acquisition for the chemical and biological warfare program, reflection of that designation in the defense budget, and oversight by the Defense Acquisition Board. (U.S. Congress, 1993, p. 342)

This designation was accompanied by the transfer of funds from the Navy and Air Force accounts to designated Army accounts specifically related to chemical and biological defense weapons. The HASC also recommended that the Army establish a chemical-biological defense program that would gain more support from the international community. The committee required that approximately $ 10.6 million of appropriated funds be transferred from Navy and Air Force program elements in research and development. (U.S. Congress, 1993, p. 113) Another indication of the importance of the chemical defense of the armed forces is the authorization and appropriation of the dollars for this equipment. The Other Procurement, Army (OPA) authorization and appropriation of CDE are shown in Figure 2-1.



DEPARTMENT OF DEFENSE AUTHORIZATIONS
OTHER PROCUREMENT, ARMY

Other Support Equipment Chemical Defensive Equipment PROGRAM TITLE	($ IN THOUSANDS) AUTHORIZATION REQUEST FY 1994 QUANTITY/AMOUNT	CHANGE FROM REQUEST FY 1994 QUANTITY/AMOUNT	COMMITTEE RECOMMENDATION FY 1994 QUANTITY/AMOUNT
SIMP COLL PROT EQUIP M20	134/1,527	0/0	134/1,527
COLL PROT EQUIP NBC TEMPER, TENT M2	0/4,366	0/0	0/4,366
MASK, PROTECTIVE, NBC M40/M42	0/43,795	0/0	0/43,795
MASK, ACFT	0/0	0/0	0/0
REMOTE SENSING CHEMICAL AGENT ALARM, XM21	0/0	0/0	0/0
IMPROVED CHEMICAL AGENT MONITOR	0/1,926	0/0	0/1,926
RECONNAISSANCE SYSTEM, FORX NBC (NBCRS) XM	0/0	0/0	0/0
DECONTAMINATE APP PWR DR LT WT M17	515/7,228	0/0	515/7,228
RADIATION MONITORING SYSTEM (OPA-3)	0/8,291	0/0	0/8,291

Figure 2-1: Chemical Defensive Equipment Authorization/Appropriations
Source: U.S. Congress, 1993, p. 38.

3. Critical technology

The technologies presented in Table V were deemed critical in a study conducted by the U.S. Army Chemical and Biological Defense Command (CBDCOM). (CBDCOM Study, 1994, pp. D-1-D-19) The criticality of technology depends on various factors. In a different study conducted by the Defense Science Board in 1990, the criterion for a defining critical technology was established as the following:

> Critical Technology: candidate technologies must meet all of the following criteria:
>
> - Provide a significant leap forward in warfighting advantage (in both quality and quantity)
> - Have a high entry barrier (no reasonable substitutes)
> - Have a relatively long transfer time to controlled countries (greater than three years). (Defense Science Board, 1990, p. 2-20)

The nature of the equipment and supplies produced by the chemical industrial base meet the requirements of this definition. The protection and survivability of soldiers for extended operations in war provides the significant leap forward in quality and quantity meets the warfighting advantage requirement. In some instances, there are no "reasonable" substitutes for the equipment provided by the producers in the chemical industrial base. There are no commercial products available to provide the level of protection afforded by the equipment and supplies provided by the producers in the chemical industrial base. Finally, there are nuclear explosive export controls to control the transfer of nuclear materials. It is likely that similar controls apply to the technology, the equipment and supplies produced by the producers in the chemical industrial base. (GAO, April 1994, p. 2)

In 1994, the Joint Logistics Commanders (JLC) tasked the CBDCOM to conduct a study on the CIB. The CBDCOM study was conducted to respond to a Joint Logistic Commanders tasking. This tasking was provided as a result of an earlier industrial base study conducted by the Headquarters (HQ), U.S. Army Armament, Munitions and Chemical Command (AMCCOM). This AMCCOM study required a more detailed assessment be conducted to assess the health of the chemical sector of the industrial base and identify any areas that may require special attention. (CBDCOM, 1994, p. 1) The segmentation of the chemical industrial base was also documented in the early industrial base sector study conducted by AMCCOM. (CBDCOM, 1994, p. 15) This AMCCOM sector study was the back bone of the CBDCOM study. It provided a framework for the CBDCOM study.

The CBDCOM study determined how the chemical industrial base can meet the requirements for all four services up to the year 2000. The study considered the impacts of the Defense Department's draw-downs and budget declines in making its assessment of the ability of the base to provide support.

The study was a joint effort, conducted by the Army, Navy, Air Force and Marines, that assessed the health of the CIB. The assessment was conducted for equipment already in use in the field, equipment in development, as well as chemically related medical items. The purpose of the study was to:

Identify those steps necessary to:

- Sustain critical elements of the industrial base;
- Consolidate future requirements to assist the future industrial base; and
- Plan for replacement of out-of-date stockage.

The CBDCOM study states the Chemical Biological Defense (CBD) sector is:

> ...a fragmented collection of subsectors. The commercial firms making up the production base are generally small to mid-size companies, and range from low to high-tech production processes. They range from specialty chemicals (decontamination materials and detector kits) to rubber molding (masks, gloves and boots) to microelectronics (automatic sensors and monitoring devices) to specialty textiles (protective suits). (CBDCOM, 1994, p. 15)

The study confirmed the make up of the chemical industrial base to be that of primarily small businesses with specialized functions in the critical chemical technology areas listed in Table V. The continued decline in the defense budget will likely make the problem conditions, such as segmentation of the base and the high level of specialization that already exist in the base, worse.

It also revealed a problem in the chemical industrial base due to the lack of a lead agency to manage chemical issues for all the services. This problem still existed in spite of the NDAA of 1994 previous designation of the Army as the lead agency. The problem existed because each service failed to acknowledge this designation and continued to procure and manage their requirements in whatever manner they deemed appropriate, which was suboptimization of the contractor and supplier assests available to service the base. Additionally, the CBDCOM study provided the M21 RSCAAL that is procured by both the Army and the Marine Corps from the same producer as an example of these suboptimizations within each of the four Services. The suboptimization resulted in unproductive guidance from the lead agency (i.e., Army). (CBDCOM, 1994, p. 15)

Finally, the CBDCOM study stated that DoD can no longer continue to do business as usual. In order for the chemical industrial base to remain viable and the contractors to remain profitable, DoD must look for new and effective ways to sustain the base.

C. DUAL-USE TECHNOLOGY

1. Definition

One means to sustain the chemical industrial base and provide viability for the contractors within the base would be to apply the concept of dual-use technology. The dual-use of technology is defined as:

> ...technology that has an indeterminate number of potential uses, at least some of which are of significant military importance and some are of material nonmilitary importance. (Branscomb, 1990, p. 37)

A more comprehensive definition of dual-use includes:

- Commercial off-the-shelf (COTS) - Identical item used for both commercial and military applications, produced on the same production line.
- Modified COTS used for military application and produced on the same production line as the commercial item.
- Different end items for military and commercial applications that use the same piece parts, modules and/or subsystem components, ideally produced on the same production line. (McIlvaine, 1994, p. 32)

Dual-use technology encompasses "everything" that results in the design and production of a major weapon system and its commercial counterpart. It includes the information scientific, theoretical and mathematical procedures used in this development and production process, no matter how common or uncommon they may seem. (Epstein, 1989, p. 4)

2. The need for dual-use

In 1991, Congress chartered a DoD Advisory Panel on Streamlining and Codifying Acquisition Law. This Panel was established by Subsection 800 of Public Law 101-510 of the National Defense Authorization Act of 1991. The Panel was to review the acquisition laws and regulations and identify areas for elimination and streamlining. This panel gained the name of "the Section 800 Panel." The Panel had three of their ten objectives related to the Government's new orientation toward what they termed a "build-down." The "build-down" referred to the changing defense budget and the move toward the dual-use of technology and preferences for commercial items. (DoD Advisory Panel, 1993, p. 5)

The Panel coined the term "build-down" to refer to the defense draw-down. The Panel reemphasized that the DoD management of the industrial base must change in order for the base to remain stable. The Panel suggested that this new orientation could increase the surge capacity of the producers in the base. This increased capacity will allow the producers to reduce their operating cost and overhead by spreading this cost over a larger base. (DoD Advisory Panel, 1993, p. 13)

The DoD dual-use strategy states that the need for dual-use arises from changes in the focus of the national security objectives of the nation. These changes include the commercial research and development (R&D) outpacing DoD R&D investments. The DoD strategy states that "defense-unique" procurements will be used only when the nation's national security objectives are at risk. (U.S. Department of Defense, 1995, p. 2) The move by DoD toward using what is available in the commercial market versus developing defense-unique items is a step toward dual-use.

3. Toward dual-use

In an effort to explore the concept of dual-use technology and maintain the technology edge for defense, the Congress established the Advanced Research Projects Agency (ARPA) in 1958 after the Russians launched a "Sputnik satellite." The agency was to investigate and monitor the "development of high-risk technology." The agency's name was later changed to Defense Advanced Research Projects Agency (DARPA) to reflect an orientation toward technology developments beneficial to the Defense Department. The purpose for establishing ARPA was to open the door for defense to gain access to the latest and greatest in technological advances made in research and development. (Davey, 1993, p. 1) With the development of the dual-use of technology concept, ARPA is the DoD focal point for dual-use technology.

The establishment of ARPA has provided many opportunities for commercial businesses to "spin-off" of the technological advances made in the military sector that are dual-use. It has also afforded opportunities for "spin-on" from the commercial sector to defense. One of the significant accomplishments of ARPA was their involvement in development of the local area network (LAN) systems which has grown to what we now know as the internet. In addition to this accomplishment, ARPA has extensive involvement in the areas of "artificial intelligence and parallel processing for supercomputers." (Davey, 1993, p. 2)

The agency mainly serves as the investment funding conduit for laboratories, universities, commercial firms and the defense department for conducting research and development in high-risk technological areas. The duration of funding for an ARPA project is limited to determine whether or not the technology will provide any benefits useful for defense. (Davey, 1993, p. 2)

The ARPA R&D budget has taken the opposite direction from that of DoD. Instead of decreasing the ARPA R&D budget has increased in "constant dollars." This increase occurs during a period when the DoD R&D budget has declined continually from fiscal years (FY) 1988 to 1993. During this period, the DoD research, development, test and evaluation (RDT&E) budget "decreased 13 percent in constant dollars while ARPA's budget doubled." (Davey, 1993, p. 5) The FY 1994 budget language for ARPA provided funding authorizations for dual-use critical technology partnerships, commercial-military integration partnerships and defense dual-use assistance extensions for $105, $35 and $50 million, respectively. It also included a strong recommendation that a program be established to provide "defense diversification loan guarantees for small and medium-sized defense companies wishing to diversify or convert. (U.S. Congress, 1993, pp. 349-350) This funding profile shows a change in the DoD mindset to forge beneficial rather than adversial relationships with the commercial industry.

In January 1992 DoD revised its acquisition strategy for all DoD agencies requiring more emphasis on advances of the agencies in science and technology (S&T). This increased emphasis provided more DoD oversight in ARPA's technological programs. However, it is believed that somehow this additional DoD oversight will inhibit ARPA's ability to capitalize on the technological benefits gained from the research and development efforts. (Davey, 1993, p. 3)

While the DoD's change in focus toward the dual-use concept is only the beginning, there are numerous issues that must be resolved with regard to the dual-use of technology. Another issue is the restrictions on which technologies can exploit their dual-use applicability. This is a key question that DoD must tackle because the dual-use of some technology will have a bearing on the national security objectives. (Wang, 1987, p. 22) This is probably why some have referred to dual-use technology as a "gray area" meaning that no clear boundaries exist to separate where the uses and benefits of technology for the military and civilian arena start and end. (Wang, 1987, p. 21) Because of this ambiguity there are other dual-use issues that DoD must resolve to gain the maximum benefits dual-use has to offer.

4. Dual-use issues

The applicability of dual-use has been a long standing issue in the mind of some defense and congressional leaders since early 1989 when the concept of dual-use was first introduced on the scene. The "applicability" of dual-use means that the technology and the production methods are common and require minimal changes to produce a military and commercial item on the same production line. This interest in dual-use sparked many studies and investigations by congressional and defense leaders. The main concern of these leaders was how the combination of the separated defense and commercial production lines of industrial base producers could take place in spite of the problems inherent in the procurement and acquisition laws and regulations. These inherent problems of combining commercial and defense production lines was the objective of a study by a Steering Committee of the Center for Strategic and International Studies (CSIS). The CSIS study was headed by a panel of notables ranging from senators to dual-use and industrial production and manufacturing experts. This committee was chartered to study the obstacles to commingling the defense and commercial production lines and efforts of defense contractors. (Opstal, 1991, p. vii)

The CSIS study's foundation was based on previous studies of the industrial base and the challenges that face the Congress and the Department of Defense as they try to salvage the capabilities within the base and keep it viable and responsive to the needs of the nation while simultaneously providing a means of profitability for the defense firms involved. (Opstal, 1991, ix) The Committee further referred to "integration," which they defined to mean that DoD "would rely more on commercial products, processes, and buying practices." It also meant that a lot of industries within the defense industrial base could use the same technologies, people, procedures, and buildings, that they use for their commercial operations for the defense operations. This idea of integrating both of these operations has been under investigation for quite some time. The general findings indicate that such an operation could potentially save the contractors, DoD, and the American taxpayers quite a bit of money. To date only limited tests of such an application have taken place and the results of cost savings vary and are program dependent. (Opstal, 1991, p. ix)

The CSIS based their reasoning for adopting a program objective of integration based on three assumptions:

- Syngeries between defense and commercial product and process technologies exist and will increase in the future.

- Greater reliance on commercial products and processes will result in cost savings to DoD for equipment of equal or greater quality and performance.

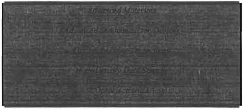
- The nation's military needs-both in peacetime procurement and crisis surge demand can only be affordably assured by tapping into a broadly based domestic industrial infrastructure. (Opstal, 1991, p. 2)

As previously stated, many defense contractors segregate their defense business from their commercial because of the cumbersome standards required to be a Government contractor. These regulatory and legal requirements are not free, they add substantial cost to the products and services provided for the Defense Department. (DoD Advisory Panel, 1993, p. 5)

The CSIS study concluded that the segregation of defense and commercial production efforts is no longer required. The study states that this is due in part to the similarities and common uses in the commercial market for what were once defense specific products. This is also due to the technological competitiveness gained by the commercial sector over the past decade. (Opstal, 1991, p. 3)

The cost for this segregation, if not discontinued, is likely to grow right along with the costs for advanced technologies. The CSIS study estimates the burdens of the legal and regulatory provisions combined with the segregation increase the costs because they require the contractor to perform extra work. For example, the study sites that contractors have to hire additional employees specifically to complete the requirements of the Government cost accounting procedures. Additionally, more personnel and man-hours are expended when the commercial firm undergoes an audit from the various Government audit agencies. The CSIS committee concluded that activities such as these (i.e., audits) do not add value. Instead, they detract from the value and sometimes cause commercial firms to avoid doing business with the Government. These non-value added requirements have also been known to force contractors to dissolve their Government sections or divisions. (Opstal, 1991, p. 5)

The need for dual-use has also revealed that the technological advances made by the commercial sector have out paced the Government for more than two decades in various markets. The Government still retains a lead over the commercial sector in the aerospace industry and satellites; however, there is growing interest in these areas from foreign Governments. A survey conducted by the U.S. Department of Commerce revealed that the Japanese and U.S. Governments are equal in several high technology research and development areas. (U.S. Department of Commerce, 1990, p. 9) The five areas of emerging technologies[5] in which the Japanese are ahead of the U.S. are depicted below in Figure 2-2.



Advanced Materials

Advanced Semiconductor Devices

Digital Imaging Technology

High-Density Data Storage

Optoelectronics

Figure 2-2: Emerging Technologies in which Japan leads
Source: U.S. Department of Commerce, 1990, p. xviii

Some countries recognized the importance of pooling their resources with their industry counterparts. They realized that this effort would not only improve the competitiveness of the industry but it would also improve the economic competitiveness of the nation. The Japanese and European Governments are currently using the concept of dual-use and merging their commercial and defense resources to achieve the optimal solutions for their nations. (Reddy, 1991, p. 74) The U.S. Government must also realize the importance of the cooperation that must occur between the private and public sector if the nation's industrial base is going to survive.

---

[5] The U.S. Department of Commerce defines emerging technology as...one in which research has progressed far enough to indicate a high probability of technical success for new products and applications that might have substantial markets within approximately 10 years. (U.S. Department of Commerce, 1990, p. 5)

5. DoD dual-use policy

The Clinton Administration strongly supports dual-use initiatives. This is evidenced by the defense strategy on dual-use technology and also by the establishment of the current technology reinvestment and the defense conversion programs at ARPA. As usual, the Congressional support for a program is usually reflected by the allocation of appropriation dollars. The ARPA fiscal 1995 spending plan for $ 2.8 billion includes $1.8 to $ 2 billion for dual-use programs. (Evers, 1994, p. 56) In May 1995, ARPA issued a joint program solicitation notice in the commerce business daily for the Technology Reinvestment Project (TRP). The solicitation was for $300 million for technology investments in several areas. Some of these areas are:

- Cryogenic Coolers for Electronic System Applications
- Electric and Hybrid Tactical and Commercial Vehicles
- Low Cost Specialty Metals Processing
- Millimeter Wave Products for Military and Civilian Applications (U.S. Department of Defense, 1995, p. 1)

The proposals from industry are due by the end of June 1995 with negotiations set for October 1995. Although the TRP is a well-intended program, the solicitation strongly urges bidders that their TRP concept papers must contain substantial scientific/technical merit. The technical merit has been designated as the most important evaluation factor but, their papers still stand the chance for rejection if they do not meet the test of relevancy of the technology to the defense needs. The solicitation also notes that "TRP is a Defense program [and that] proposals that do not present a compelling Defense benefit will not be funded." This could recreate the problem that DoD is currently trying to remedy, avoiding defense-unique items. (U.S. Department of Defense, 1995, p.1)

The DoD policy on dual-use technology is that dual-use is:

> A key component of DoD's investment strategy for maintaining the performance superiority and Affordability of U.S. military forces in this new technological and economic environment. It builds upon the

> successful DoD acquisition reform effort. Elements of dual-use technology investment strategy serve to: (1) ensure that key elements of the domestic commercial technology base that are critical for national security remain at the leading edge; (2) support the transitioning of defense-sponsored technology and the integration of military production with the commercial base; and (3) facilitate insertion of commercial technologies into military systems. The benefits for the DoD will be better products--developed faster and at a lower cost--and a vigorous, productive, and competitive commercial industrial infrastructure which, when coupled to the superior systems integration capability and defense-unique technologies provided by defense contractors, will ensure a superior U.S. military. (U.S. Department of Defense, 1995, p. 1)
>
> This policy is based on "Three Pillars" with:
>
> Acquisition reform as a foundation, are supporting a change in the DoD defense-unique "culture" that will permit DoD to maintain state-of-the-art performance and affordability in military systems.
>
> - Pillar 1 - dual use technology investment in R&D on dual-use technologies
> - Pillar 2 - "dual-produce" integration of military into commercial production
> - Pillar 3 - insertion of commercial capabilities into military systems (U.S. Department of Defense, 1995, pp. 7, 17, 23)

This policy reveals that DoD recognizes the potential dual-use offers for defense (i.e., lower acquisition cost, earlier fielding) as well as the benefits for the commercial customer, stronger more reliable business base. These potential benefits clear the way for success in implementing dual-use within DoD.

6. Dual-use success

In addition to policy issues on the dual-use of technology, the practical application of this concept applied to a weapon system acquisition would be beneficial. Perhaps the most successful application of dual-use is the non-developmental acquisition of the Global Positioning System (GPS). GPS is a:

> dual, military and civilian use system. It provides standard positioning service (SPS) for civilian users who gain access to the system using commercial available receivers. For U.S. military and selected allies. The Precise Positioning Service (PPS) is available via the incorporation of embedded encryption algorithms....(Sweeney, 1993, p. 39)

In 1990 the Army had an ongoing development for GPS systems since 1976, with each system estimated to cost more than $40,000. The initial requirements projected by the Army were around 900 systems. The arrival of ODS quickly changed the situation and necessitated the accelerated development and production of the system. The system that was under development at the time was the AN/PSN-8. This system weighed approximately 17 pounds and could be carried by vehicle. However, the initial estimated cost of $40,000 had now ballooned to around $ 2 billion to acquire the because of the need to buy 60,000 total systems. The quick fix for ODS was for the Army to acquire 8,000 lightweight GPS commercial receivers ruggedized for military use. These receivers weighed only 4.1 pounds and the estimated cost for this small lightweight GPS receiver (SLGR) was estimated to be about $4,000 each. (Sweeney, 1993, p. 39)

This switch to a nondevelopmental type of acquisition for a commercial-off-the-shelf item (COTS) required tradeoff on some requirements since the Non-developmental Item (NDI) configuration would not match the performance requirements of the original AN/PSN-8. Typically, NDI systems require some modifications. The extent of these modifications can alter the system so much that it may not meet the requirements of the operational requirements document (ORD). The Government involvement of the user early on in this process was key to the success of the program. The program encountered numerous legal battles and set legal precedence in NDI acquisition strategy. The courts determined that:

> The Government, under an NDI acquisition, can properly acquire a system which may not exist at the time of project initiation. The courts stipulated that Government use of an NDI strategy was permissible if the system was

> to be otherwise in production at the time of Government contract award. (Sweeney, 1993, p. 40)

The success of this dual-use effort clearly demonstrates that dual-use can work for the Government. The key is communication and coordination between all the key players in the process and a well thought out plan.

This chapter presented background information and a literature reviews necessary for the reader to understand the DTIB, CIB the concept of and dual-use technology. The sustainment of the DTIB and CIB are important for the supply and support of the U.S. armed forces in national emergencies. The DTIB was initially established to provide long term war support. But overtime with advancements in weapon systems and technology used in war this industrial base support has also changed.

Technology is important to the CIB because it will provide the leverage necessary to attract new producers to the base and sustain the current producers. The DoD and other agencies within the Government have acknowledged the importance of advanced technology to small businesses in the DTIB. This acknowledgment is accomplished through the programs under the auspices of ARPA such as TRP.

The dual-use technology concept offers the potential for sustainment of the CIB. It also offers the potential benefit for lowering the production and start-up costs and a means to attract new producers and stabilize the current producers. The dual-use of technology concept also provides a method to keep a continuous industrial base production line running at all times. With all the potential for benefits from dual-use there is one important drawback that merits further investigation. The dual-use of the technology of defense weapon systems poses a national security risk because capabilities and limitations of these systems will be known by all.

The next chapter provides the methodology used to conduct this research.

III. RESEARCH METHODOLOGY

A. INTRODUCTION

The first two chapters of this thesis described the existent problems in the defense industrial base and the chemical industrial base. These problems are mainly due to the specialized production capability and the nature of the products and services produced by the chemical industrial base unique to defense. This is also due to the number of producers from the commercial sector available in the base with a capability to support the chemical defensive needs of the nation. The growing deficit places more emphasis on the ability of the defense department to sustain a chemical industrial base that is technologically capable to support wartime needs. (U.S. Congress, 1993, p. 338)

The DoD and other defense agencies have made attempts to use some form of dual-use technology. This concept of the dual-use of technology is the Defense Department's first real attempt to try to resolve some of the dependency of defense contractors on the Government. It is also an attempt by some defense contractors to actually market their products and services to customers other than the Government.

As stated in the previous chapters, the application of dual-use technology to the chemical industrial base could potentially allow producers to improve their ability to succeed in the commercial sector. The improved contractor potential provides the technological edge needed of the industrial base for national emergencies and contingencies.

The researcher generally believes that some form of the dual-use of chemical defensive equipment technology is feasible. The researcher questions if there is interest in the commercial market for the products and services produced by the chemical industrial base.

This chapter describes the methodology used to conduct the research to obtain opinions regarding the applicability of dual-use to the chemical industrial base and the potential benefits. These opinions were obtained through interviews with Government and Defense contractors who are involved in the DTIB, and the chemical industrial base or any area of dual-use technology. Specifically, this chapter discusses the:

- Method of data collection
- Construction of the interview questions
- Interview length
- Selection of interview respondents or interviewees
- Conduct of the interview

B. DATA COLLECTION METHOD

In determining the method and level of detail to use in this research, the researcher used the dendritic analysis techniques. The dendritic analysis techniques are defined as:

> An effective way of decomposing critical issues to the point where actual data requirements and test measurements can be identified...issues are successively broken down into objectives, measures of effectiveness (MOE), measures of performance (MOP) and data requirements...measures of effectiveness are developed as subsets of the objectives and are designed to treat specific and addressable parts of the objectives. Each MOE, is traceable as a direct contributor to one objective and through it, is identifiable as a direct contributor to addressing one or more critical issues. (DSMC, 1993, p. 14-7)

The dual-use dendritic approach is presented in Figure 3-1. The figure is composed of the primary and subsidiary research questions. The questions were broken down into more details until a data source or data element could be identified for obtaining the information required to answer the primary research question.

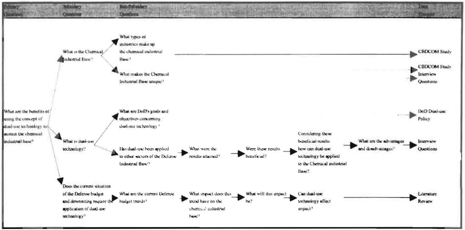

Subsidiary Questions
Sub-Subsidiary Questions
Data
What are the benefits of using the concept of dual-use technology to sustain the chemical industrial base?
What is the Chemical Industrial Base?
What types of industries make up the chemical industrial Base?
CBDCOM Study
What makes the Chemical Industrial Base unique?
CBDCOM Study
Interview Questions
What is dual-use technology?
What are DoD's goals and objectives concerning dual-sue technology?
DoD Dual-use Policy
Has dual-use been applied to other sectors of the Defense Industrial Base?
What were the results attained?
Were these results beneficial?
Considering these beneficial results how can dual-use technology be applied to the Chemical industrial Base?
What are the advantages and disadvantages?
Interview Questions
Does the current situation of the Defense budget and downsizing require the application of dual-use technology?
What are the current Defense budget trends?
What impact does this trend have on the chemical industrial base?
What will this impact be?
Can dual-use technology affect impact?
Literature Review

Figure 3-1: Dual-Use Dendritic Approach

The use of demographic information is also important in the interview process. This information usually provides the researcher with information on the cultural and educational perspective of the respondents. The interview questions and demographic section are at Appendix A.

1. Telephone interviews

The questions were asked by phone in the same manner as if the interview were being conducted face-to-face. (Sudman, 1983, p. 267) The research on conducting interviews suggests that in order to make telephone interviews more beneficial the use of two interviews should be used. The researcher used a two-step approach. The first step of the interview was to establish initial contact. For this research, the first interview was used to request the respondent's participation and gain agreement to conduct the interview. It was also used to obtain the information necessary to provide an advance copy of the interview questions (i.e., fax numbers). The second step of the interview was used to conduct the actual interview. (Sudman, 1983, p. 272)

The researcher initially established a two-week period to conduct and complete all interviews. Besides this two week period, the researcher allowed additional flexibility to extend the schedule depending on the availability of the interview respondents. The final frame used to conduct the interviews was 26 April 1995 through 28 May 1995. The time length for conducting an interview was 20-30 minutes.

Interviews were conducted with the experts in DoD and the commercial sector. The limited time and resources available to the interviewer allowed interviews to be conducted with five current chemical industrial base producers. The focus of the interviews was to determine their perspective on dual-use of the technology prevalent in the base and its applicability. The researcher selected the telephone interview rather than surveys or questionnaires because of time constraints.

2. Question construction

The thoughts and feelings of a person can be best attained by asking open-ended questions. (Patton, 1990, p. 278) The "standard open-ended interview" question is:

> A set of questions carefully worded and arranged with the intention of taking each respondent through the same sequence and asking each respondent the same questions with essentially the same words...The standardized open-ended interview is used when it is important to minimize variation in the questions posed to interviewees. (Patton, 1990, p. 280-281)

The characteristics of and the strengths and weaknesses of the standardized open-ended interview are provided in Table VI.

TABLE VI: Characteristics of the Standardized Open-ended Interview

Characteristics	Strengths	Weaknesses
The exact wording and sequence of questions are determined in advance. All interviewees are asked the same basic questions in the same order. Questions are worded in a *completely* open-ended format	Respondents answer the same questions thus increasing comparability of responses; data are complete for each person on the topics addressed in the interview. Reduces interviewer effects and bias when several interviewers are used. Permits evaluation users to see and review the instrumentation used in the evaluation Facilities organization and analysis of the data.	Little flexibility in relating the interview to particular individuals and circumstances; standardized wording of questions may constrain and limit naturalness and relevance of questions and answers.

Source: Patton, 1990, p 289.

In deciding to conduct telephone interviews, the development of the interview questions was an important issue. Stanley L. Payne, author of *The Art of Asking Questions,* states that:

> Question wording involves more than toying around with this word and that to see what may happen, however. It is more than a mere matter of manipulation of words to produce suprising illusions. The most critical need for attention to wording to make sure that the particular issue that the questioner has in mind is the particular issue on which the respondent gives his answer. (Payne, 1951, p. 9)

The questions and their wording were extremely important to ensure that desired responses were received. Mr. Payne also states that the interviewer, in order to assure that the issue he or she is trying to obtain answers to, must be somewhat if not thoroughly understood by the respondent. Mr. Payne further states this assurance is a direct function of the wording of the interview questions. (Payne, 1951, p. 10) This had an impact on the design and selection of the interview questions developed by the researcher.

The use of demographic information is also important in the interview process. This information usually provides the researcher with information on the cultural and educational perspective of the respondents. The interview questions and demographic section are at Appendix A.

The researcher considered the information desired to be collected and chose the open-ended questions. The open-ended question was selected over the closed-end question because the researcher wanted to allow room for the interview respondents[6] to elaborate more freely on their opinions about the research issue.

3. Procedures for selection of respondents

The procedures used to determine which personnel would be selected for the interview were important to the conduct of this research. These procedures were based primarily on involvement and expertise of the personnel in the area of research (i.e., dual-use technology, chemical industrial base, and defense industrial base). The researcher expected difficulty in selecting individuals who met these requirements and, also possessed an interest in conducting the interview. This anticipated difficulty was encountered in only one instance. In this instance the researcher selected an interview respondent that met the requirements but was reluctant to conduct the interview. The researcher requested the respondent recommend another individual with similar experience with a willingness to conduct the interview. The interview participant's agency and the agency's involvement or expertise in the areas of research were also considered. During the literature review and background research, the researcher noted individuals and agencies with involvement in dual-use technology, the defense industrial base, or the chemical industrial base. The CBDCOM study was also used as a source for interview points of contact. Additionally, contacts from prior job experiences were used to obtain possible interview respondents.

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[6] The terms interview respondents and participants are used interchangeably.

4. Conduct of interview

Each agency selected for interview was contacted by telephone and requested to provide a participant for the interview. The agency reviewed the list of questions and selected the individuals with experience in one or more of the areas listed above. In the selection of the Government personnel, the Program Manager (PM), Deputy, Program Manager (DPM) or supervisor determined whom the designated individual would be. In the selection of non-Government personnel and defense contractors, the company President or Marketing Manager determined who the respondent would be. The designated participant was provided a copy of the interview questions and introductory letter by fax. The introductory letter and interview questions at Appendix A were provided to each participant at least four days before the interview. The introductory interview letter was provided to interview participants to establish a minimum baseline for the subsequent interview. This baseline was a simplistic definition and example of dual-use technology. A simplistic definition was provided primarily because the researcher assumed each participant had some knowledge of dual-use technology, chemical defense equipment, and the make-up of the chemical industrial base. Considering this assumption, the researcher's minimal definitions were used to determine the validity of this assumption. Confirmation of the receipt of the interview questions was by phone. The time between faxing of the introductory letter, interview questions, and scheduling allowed the participants time to review the questions and focus on the answers they planned to provide.

The interviewer was consistent throughout each interview. This consistency was obtained by reading the questions verbatim as shown in Appendix A. If the interviewee provided responses that were too general, the interviewer asked if the interviewee to elaborate on that particular area. If the respondent indicated he or she was pressed for time, the interviewer's goal was to complete the interview first and upon completion of the interview to revisit any areas that needed additional clarification.

Interviews were scheduled and conducted at the date and time scheduled. This time was according to the convenience and availability of the participant. The various time zones in which the interviews would be conducted required close coordination to ensure that time differences did not interfere with the scheduling of the interviews.

The researcher informed all participants in the introductory letter that the anonymity of the responses of each participant was assured due to the combination of their responses with the responses of all other interviewees. The researcher started each interview with a brief introduction of herself. This introduction was followed with notification to the interview participant that the interview was being recorded only for the purpose of enriching the data gathering process. The researcher concluded the interview by thanking respondents for their time and participation in the interview.

5. Data analysis

For this research, the researcher determined the best way to analyze the data would be to first transcribe each interview tap onto an interview form. After this was completed, the responses to each question were consolidated by interview respondent. The researcher did not make any summaries, inferences or interpretations about what an interview respondent meant by an answer. The researcher compiled all responses to each question. This compilation of responses permitted a thorough review to annotate any repeated responses. The researcher also reviewed the compiled responses for topics frequently mentioned among respondents. In addition to the areas most mentioned, the researcher reviewed the responses to determine if any pattern existed among the respondents. Following this review, the compiled responses were further reviewed to determine the perceptions that existed among the interview population about dual-use and the CIB.

The researcher used the CBDCOM study as a starting point to indicate the problems such as the lack of an established method to sustain the CIB in the face of downsizing. The CBDCOM study provided assessments on the CIB production capability as well as the availability of the producers in the CIB that were used for this research.

The interview questions asked respondents to provide ideas on who, what, when, where, and how regarding dual-use and the CIB. Interviews were conducted with experts in the DTIB, CIB and the dual-use technology concept.

The next chapter will present the findings and analysis of the interviews.

IV. FINDINGS AND ANALYSIS

A. INTRODUCTION

The dual-use of technology in the chemical industrial base can provide numerous benefits for the Government as well as defense contractors. The research indicates that the previous DoD paradigms did not promote the dual-use of technology. These paradigms relate to the defense procurement system and the legal and regulatory requirements. During this research it was surprising that only a few of the interview participants were aware of or mentioned the changes being made in the acquisition process.

The reforms in the acquisition process relax some of the requirements for documentation in DoD contracting and alleviate the use of military specifications. The changes concerning the dual-use of technology are the DoD preferences for NDI, COTS and commercial specifications.

The researcher used interviews to obtain the perceptions of Government, academia and defense contractors concerning the applicability of dual-use technology as a means for sustaining the CIB. This chapter presents and discusses the results of the interviews conducted to support this research.

B. OVERVIEW

A total of 19 interviews was completed during the period of 24 April 1995 to 28 May 1995. Several other organizations and individuals were slated to be interviewed; however, the researcher was unable to successfully make contact prior to the cut-off date of 28 May 1995. The individuals that were contacted were very interested in participating in the interviews.

The researcher used a two-step interview process. The two-step process allowed the interview respondents an opportunity to review the questions and think over their responses prior to the interview. In some instances the interview respondents had written out their responses and read their responses to each question during the interview. The interviewer initially planned for the interviews to last approximately 20 to 30 minutes in duration. The average interview time was approximately 30 to 35 minutes at the start of the interview process on 24 April 1995. The time had averaged out to be approximately 15 to 20 minutes by the end of the process. The researcher attributes this time difference to learning interview procedures and experience gained over time. During this 24-day period, the researcher learned how to administer interviews and answer questions about the interview questions without prejudicing the respondents' answers. As the researcher conducted more interviews and gained more experience, the effects of inexperience with the interview process became minimal.

1. Demographics

The interviews collected demographic information on the respondents. The demographic information determined the average experience of personnel in the dual-use of technology and the industrial base issues. There were three categories of interview respondents. The first category included 13 Government personnel. The highest grade level among Government personnel was General Services (GS)-15. The lowest grade level was GS-11. Among the second category, defense contractors, the highest level of personnel interviewed was vice-president. The lowest level was the director or coordinator of a division or branch within the company. The last category included one academic interview respondent who was a full professor at an ivy league university with an extensive background working dual-use technology as well as industrial base issues.

The overall average years of experience working dual-use technology issues was 11.15 years. The average years of Government experience, among the personnel interviewed was 20.82 years. Finally, the average number of years in their current job position was five years.

The demographics revealed that non-Government respondents each had some previous experience with the Government. This meant that the respondents were aware of the Government way of doing business. All the interview respondents worked in the

Eastern United States. These locations ranged from Boston, Massachusetts to Washington, D.C.

The results and the overall comments provided in response to each interview question have been consolidated and the combined analysis of each is presented in this chapter.

*2. **Has your agency, corporation, institution used dual-use technology?***

The research reveals that there has been limited use of the dual-use technology concept by DoD agencies, defense contractors, and academia. This question was answered affirmatively by approximately 74 percent of the interview population. The range of areas in which the dual-use technology concept was currently being used are:

- Development of drug therapies
- Non-developmental items and commercial-off-the-shelf items
- Military detection devices for hazardous industrial chemical materials
- Military production facilities (Government Owned Contractor Operated (GOCO))
- Cooperative Research and Development Agreements[7]
- Filtration
- Infrared technology

The range of areas provided by the interview respondents appeared to show a trend or pattern. This pattern seemed to be linked to the amount of experience and expertise the interview respondent had in the areas of dual-use and the CIB. For example, among respondents with five years or more experience working dual-use technology issues, 47 percent responded affirmatively and supported their responses with examples. Only 21 percent of the respondents with less than five years experience in dual-use issues responded affirmatively with specific examples. To contrast this with negative responses, there was zero negative responses from interview respondents with five years or more experience in dual-use. While there was twenty-one percent negative responses from interview respondents with less than five years experience, reveals that a response pattern is developing. This denotes that additional information would be required for further evaluation of this area.

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[7] A Cooperative R&D Agreement is an arrangement by which both industry and the Army can benefit by working together on a problem of mutual interest. Industry gains access to the Army's qualified scientists and engineers, valuable patents and technical data, and computer software. The industrial partner can exclusively exploit the resulting intellectual property for commercial purposes, while the Government retains a license for its use. The nation benefits from a strengthened industrial base and enhanced global competitiveness. This new program creates exciting opportunities for teamwork between industry and Army R&D organizations, coupled to Battle Labs...(Army Material Command, p. 14)

One interview respondent stated that the dual-use technology concept also applies to the dual-use of the facility. The interviews revealed that an attempt by one contractor to attain dual-use of his facility gained no interest or support from DoD. The producer presented an idea to DoD related to a method that could be used to help chemical producers and other small businesses retain their business and market viability. The producer offered DoD a trade to retain the production capability for chemical industrial base items. The interview respondent stated that in return, DoD was requested to buy products produced for commercial sales by the contractor. The Defense Department was reluctant to participate in this business venture. The respondent further stated that DoD did not provide rationale for this decision.

3. Do you know of any other agency that has used dual-use technology?

The results among the entire interview population were that there is some knowledge on the dual-use of technology by agencies within and outside DoD. The agencies within DoD are listed in Figure 4-1 and agencies outside of DoD are shown in Figure 4-2.

U.S. Army Chemical and Biological Defense Command (CBDCOM)

Advanced Research Projects Agency (ARPA)

U.S. Army Communications and Electronics Command

Figure 4-1: Department of Defense Agencies that use Dual-use Technology

Department of Energy

Department of Commerce

National Aeronautical Space Administration

Department of Agriculture

Figure 4-2: Agencies outside DoD that use Dual-use Technology

The knowledge outside the defense sector was limited to a basic knowledge on the concept of dual-use. Approximately 70 percent of the personnel interviewed knew what the term "dual-use technology" meant and knew of agencies that were using the concept. The awareness was somewhat limited on the specialized equipment produced in the chemical industrial base. Although 70 percent of the personnel interviewed were knowledgeable about dual-use, of that 70 percent, approximately five percent were less knowledgeable about chemical defensive equipment. Although the interview population was aware of dual-use, the current applications of dual-use in other areas of the CIB and the DTIB permits the researcher to conclude that dual-use can be applied to other sectors of the DTIB. The interview respondents perceived that a more specific knowledge basis is required when you want to apply dual-use in a specific area.

4. Do you think the dual-use technology concept can be applied to defensive chemical equipment in the Chemical Industrial Base? Why?

Seventy percent of the personnel interviewed indicated that the concept of dual-use technology could be applied to the chemical industrial base, the reasons they supplied varied among the interview respondents. The reasons ranged from "it is a good idea because of the budget cuts and downsizing," to "some of the chemical protective equipment used in defense can be used as safety equipment for industrial workers." Some other reasons for the applicability of dual-use technology to the chemical industrial base are:

- Potential dollars saved in RDT&E. These dollars can be used by private industry for other efforts. DoD would benefit from these savings by procuring off-the-shelf equipment at a lower cost.

- The use of commercial technology would expand the logistical support by industry to DoD

- Chemical/Biological detection can have many uses not associated with passive defense

- Most all technology can be applied to industrial safety because they have similar base technologies

- Detecting airborne vapors do not have to be military chemicals

- It is being done now by ARPA

Table VII shows some of the areas the interview respondents felt dual-use technology could provide benefit to the CIB.

TABLE VII: Areas Dual-use is applicable to the Chemical Industrial Base

Safety equipment for fire fighters & hazmat workers	Industrial safety against cyanide and organophosphates
Detection technology for detecting all types of airborne contaminants	Carbon monoxide detection
GOCO facilities	Treaty verification
Environmental and ecological detection	Medical therapies
Biodefense with HEPA filters	Masks could be used by private residences and in countries with high terrorism risks
Protection against Pesticides	Lots of similar base technologies with the commercial sector that military could use as COTS
Decon agents could be used by fireman and industrial waste handlers	

In general, the interview responses indicated that the applicability of dual-use is somewhat situation dependent. The interview respondents perceive dual-use as situation dependent because in the words of one respondent "the commercial market is not ready to pay military prices for some of these items." Another respondent stated that dual-use is situation dependent for collective protection equipment (CPE) because "no company can produce CPE at the system level in this business." Another respondent perceived that the dual-use application to CPE could only be done at the component level (i.e., CPE consists of components such as a motor, environmental control unit, etc.). Finally, one interview respondent perceived dual-use as being situation dependent due to the "unusual nature of chemicals."

One respondent stated that his agency was doing more than dual-use of the technology as defined in this research. The interview respondent referred to this research definition as the "purest form" of dual-use. Considering this definition, the respondent stated that his agency was mostly involved in the dual-use of the manufacturing and production facilities, more specifically ammunition plants. These facilities are Government owned and Contractor operated (GOCO). In this instance, the agency has found considerable benefits from the dual-use of the facility by the contractor. The respondent stated that the Government is able to maintain the facility for later uses in national emergencies and contingencies at reduced or no cost to the Government. The respondent also stated that the dual-use of the facility may require the Government to absorb an extraordinary amount of cost if there is a catastrophe. In this instance the Government's most substantial cost would be in the areas of indemnification[8] and fungability[9]. There are two ways of dealing with fungability and indemnification. These ways are: (1) requiring the contractor to purchase liability insurance, or (2) the Government in its sovereign capacity is self-insured and offers indemnification to the contractor for damages if there is an accident. The dual-use of the facility requires the Government and the contractor to make trade-offs. The tradeoffs of this issue will be situation dependent. For the Government, if the contractor is required to insure himself then there is a potential for increased item cost in the contract. But if the Government, as a sovereign, self-insures then there is also the potential for lower item contract cost. The Government in this situation should conduct both cost and risk analysis to decide which is the best course of action.

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[8] Indemnification is the process that the contractor uses to identify high risk chemical processes required forboth environmental or hazardous materials required to operate Government contracts. There are two ways of resolving this issue: (1) The Government forces the contractor to buy insurance, or (2) The Government as a sovereign, self-insures. The latter is the preferred method because if anything happens the Government recognizes their responsibility to pay.

[9] Fungability is the process of identifying responsibility for damages if there is an accident or catastrophic occurrence at the GOCO facility. This term is very important primarily because the dual-use of a production facility by the Government and contractor simultaneously uncovers problems and difficulties never before encountered. It becomes difficult to establish responsibility for damages if these ground rules are not explicitly laid out in some type of agreement up front.

5. What is wrong with the production of defensive chemical equipment in the chemical industrial base that could be remedied by applying dual-use technology?

Thirty-two percent of the interview population voiced opinions on problems in the chemical industrial base that could be remedied by applying dual-use technology. The problems ranged from "a lack of standardization for the chemical defensive equipment among the four Services," to "the faulty DoD procurement process." The problems in the procurement process relate to the lack of DoD assistance in providing or promoting capital investment programs to help with start-up costs.

In general, the interview respondents stated that there are various problems associated with the production of defensive chemical equipment. Some of these problems are:

- Small quantity buys that yield insufficient business involvement
- Large start-up costs
- Duplication of efforts and equipment between the services
- Unique nature of the chemical defensive equipment produced for the Government
- Chemical Industrial Base is made up of mainly small companies with insufficient production for smaller buys that will result from budget reductions
- Capital investments are larger in comparison to benefits attained
- The Government acquisition and procurement process is the problem
- Retention of domestic producers is not a preference for DoD

One respondent felt that there is a perception that a smaller number of businesses were involved in producing chemical defensive equipment because of the stigma associated with producing chemical warfare items. The respondent felt that this stigma combined with the small quantity buys were sufficient detractors big commercial companies that are looking for big dollar payoffs. The respondent further stated that some of the items produced in the CIB are not well known in the industrial community.

One respondent felt that the biggest production problem was start-up cost. The respondent stated that it is very costly to set-up and use equipment solely for the military. The respondent stated that the Government should pay its industrial partner to gear up to build defense equipment. The respondent further stated that dual-use would lower the start-up cost for the Government because the equipment would already be in use for commercial production.

A requirement of newcomers to business with the Government is an immense amount of upfront capital investment. There are very few, if any, programs in the Government to help contractors meet this upfront capital investment. Besides advanced payment and guaranteed loans that help contractors once they have obtained a Government contract, no programs currently exist to help with start-up costs. Chapter II discussed the problems small businesses confront obtaining these start-up investments. One interview respondent stated:

> Downsizing shrank DoD to a size that demonstrates how costly it is to maintain a production base in a layaway state. Dual-use or joint use allows the overhead burden to be shared. This dual-use means we can have the facility in a layaway state at little or no cost to the Government. Dual-use of the facility allows commercial contractors to produce, use, maintain, and repair the facility.

One respondent stated that DoD has to standardize similar CIB items between the Services. The respondent stated that he recognized that each Service has a unique mission but that there is too much duplication between the Services. Another respondent stated that more standardization of products would permit the lowering of overall costs and that may be more attractive for new industries to do business with defense.

Another respondent stated that if a piece of equipment can be used as-is it probably would save DoD money, rather than having a requirement unique to defense.

One respondent's perception was that there is nothing wrong with the DTIB nor the CIB, rather the problem is in the cumbersome Government procurement process. The respondent felt that this process forces compliance with restrictive rules and regulations that deter contractors from the desire to do business with the Government.

The chemical defensive equipment required to support U.S. armed forces is not equipment used on a daily basis. It is required on an as needed basis and receives only the dollars requested in the DoD budget, unless there is a specific chemical defensive program that is favored by Congress.

6. If dual-use technology is applied to the defensive chemical equipment in the chemical industrial base, should there be special procedures or instructions on how, when and where to use the concept to ensure it is applied effectively?

Forty-seven percent of the interview respondents felt that the use of special procedures and instructions should be situation dependent due to the special and unique nature of the items produced in the chemical industrial base. Currently DoD has an immense amount of rules and procedures that govern the acquisition process. These rules apply across the board regardless of the item being produced or the contractor producing the item. The Federal Acquisition Streamlining Act of 1994 (FASA) changed some of these rules. The revised acquisition rules focus on deleting any non-value added steps from the process. The act emphasizes a preference for NDI, COTS and commercial specifications, just to name a few.

One interview respondent stated that many defense-unique items have subcomponents similar to items in the commercial sector. The similarities make it easier to apply dual-use technology; however, the ease of dual-use application does not come without drawbacks. One respondent stated that the drawback of allowing the dual-use of technology in the chemical industrial base permits the technology to be available for all to use. The respondent also felt that this availability will disclose not only the strengths of the system but also its weaknesses. If these weaknesses are known by the general public, they will also become common knowledge to the enemy. Another interview respondent stated that the need for special procedures would be necessary to restrict this knowledge from the enemy. The enemy's knowledge of our system weaknesses poses a national security risk. In general, interview respondents felt that special procedures should be used on a case-by-case basis to determine the national security threat posed by the dual-use of the technology.

One respondent thought special procedures would also be helpful in identifying the intellectual property rights of the information, ideas, and materials resulting from a dual-use production effort. One respondent's agency was involved in resolving the issue of the intellectual property rights of the Government and the contractor. According to the respondent, his agency would establish the intellectual property rights of the Government and the contractor in a memorandum of agreement (MOA). This method is currently being used by the agency in the dual-use of a facility. The agency uses a facility contract to layout responsibilities and liabilities of the Government and the contractor.

Forty-two percent of the respondents felt that the addition of special procedures for the dual-use of technology would add to the already burdensome process of management requirements for Government oversight.

One respondent stated that dual-use is an area that has many shades of gray. The grayness results because on the one hand, the Government would like to specify the technology that should be available for applications of dual-use. But on the other hand, if the Government continually tries to dictate to the contractor "how" things should be done rather than promoting the "what" (i.e., dual-use of technology) the Government stands the risk of losing contractors rather than attracting more contractors with state-of-the-art technology into the DTIB.

7. Of the chemical defensive equipment produced in the chemical industrial base, which lends itself more to the use of dual-use technology?

In general, the interview population felt that the chemical industrial base areas that lend themselves most to the dual-use of technology would be limited to the areas of chemical, biological and radiological detection as well as the area of particulate filtration.

One interview respondent stated that the application of dual-use to the equipment produced in the chemical industrial base would be primarily at the subassembly level. The M48 particulate filter produced for the M1A1 Abrams Tank is an example. The military carbon used to produce this filter is capable of handling military and commercial chemical contaminants. This means that dual-use could be beneficial because the carbon used to produce the military filters can also be used for producing the commercial filters. The respondent also stated that the carbon used currently for the commercial grade particulate filter is a lower-level carbon and cheaper than the military-grade carbon used to make the M48 filter. The manufacturing processes for both the commercial and military-grade filters are similar; however, the respondent was not sure if the commercial grade carbon could meet the military requirements.

Another interview respondent felt that the area of biological detection is also an area well suited for the dual-use of technology. One interview respondent perceived that biological detection had the largest allocation of research and development funding in the current budget. The respondent stated that it is common knowledge that the authorization and appropriation of dollars by Congress clearly show the congressional importance of this area. Another respondent felt that biological research for vaccines was another area with dual-use potential. The respondent cited that vaccines developed for the civilian sector can also be used for the military.

One respondent stated that components such as ion material and rubber molding are used in the manufacture of individual protective masks. The respondent stated that the similarities in the use of rubber molding and ion materials used in a variety of commercial applications could also lead to another dual-use opportunity.

One respondent felt that with slight modification the detection equipment used by the Government can be used by the commercial sector for monitoring and detecting hazards in industrial operations. The respondent also felt that there were environmental hazards and pollutants that Government detection equipment could be used for. Another respondent felt that dual-use was applicable within the detection area. Specifically, the passive infrared sensor area has tremendous dual-use potential. The system software would require some software adjustments and training would be required for separate applications. The passive infrared sensor area is one that can add value to the commercial domain in magnetic resonance imaging (MRI). This technology is currently in use in the U.S. Army and Marine Corps in the M21 Remote Sensing Chemical Agent Alarm (RSCAAL). The military application of this technology allows remote detection up to five kilometers away. This remote detection is attractive in the commercial sector where human safety is very important. This is not to say that the safety of our women and men of the armed forces is less important, but the general public is concerned more with consumer product safety.

One respondent stated that mass spectrometer technology also has some dual-use potential. The respondent spoke of the technology used in a foreign-produced chemical detector called the Chemical Agent Monitor (CAM). The respondent described the CAM as a handheld detector that can be carried to the chemically contaminated areas. It could also be used to detect hazardous chemical spills by industrial chemical plant workers in proper protective gear. The respondent further stated that alarms and detection devices such as the CAM can also be used by individuals in their private homes.

One respondent felt that radioactive monitoring equipment was also an area with dual-use potential. The respondent stated that radioactive monitoring is currently used in the commercial sector by two agencies. These agencies are the Environmental Protection Agency (EPA) and FEMA.

Four respondents felt that the collective protection equipment (CPE) also has dual-use potential. These respondents stated that CPE provided military protection against radiological fallout, and be used in the commercial sector to provide a safe zone for hospitals if there is a national emergency. The CPE shelters can also be used to provide protection from areas contaminated by toxic chemicals.

One respondent felt that the dual-use of the facility is just as important, if not more so than the dual-use of the technology. As mentioned earlier, this respondent's agency is practicing the dual-use of their ammunition production facilities as GOCOs. These GOCO facilities make explosive propellants such as TNT and composition B. Some of the components like the timers and fuses required to set off these explosives are all made by the same manufacturer. The timers and fuses made for Government explosives would be practically the same for commercial explosives.

During the interview and discussion of this issue, several chemical defense contractors expressed their frustration with the Government and its efforts to help sustain contractor viability in the chemical industrial base. This frustration has caused one contractor to discontinue his production of defense products. This contractor was a proven and reliable producer for many years. He was also considered to be the leader in his field by many. The departure of this contractor has left the chemical industrial base without a proven producer with the capability to fulfill the requirements in this critical area. There are a few other domestic contractors attempting to meet the requirement gap in this area. Meeting the requirements means the contractor can successfully produce the item and deliver on time. To date, only one domestic producer has been able to meet the requirements in this area, and this has not been without problems. The problems encountered by this small firm have been sufficient to force this firm from the industry leaving the base, again, without a viable producer.

One interview respondent stated that, in an effort to handle some of the challenges faced by all producers, but especially chemical producers retain viability as defense contractors, some firms have attempted to barter with the Government. The respondent felt that these bartering efforts all relate back to the dual-use of the contractor's facility. The respondent felt that it was acceptable for a contractor to request the Government procure his or her commercial products in exchange for maintaining production capability for a Government-unique item. The respondent generally felt that the Government should be willing to participate in this type of effort, however, the Government expressed no interest in such an effort.

During the interview of this question, several other issues were discussed. These areas ranged from "dual-use being only part of the solution" to "DoD enhancing the efforts of market research teams." The respondents, in general, felt that dual-use is only part of the solution for DoD to sustain the defense industrial base. One respondent stated that there are other problems in the defense industrial base that cannot be fixed with dual-use. The problems perceived by the respondent relate to the lack of standardization between the Services, failure of mobilization planning, and failure to resolve reliance on foreign producers for critical items. The respondent stated that each Service has its chemical items, some of which are even produced by the same manufacturers.

While discussing the areas that were best suited for dual-use, one respondent with some mobilization planning experience stated that dual-use could help eliminate the reliance on foreign producers for critical CIB items. The respondent stated that during the war with Iraq the DoD discovered that all the years of mobilization planning were insufficient to supply the needed protective mask filters. The respondent stated that during the Gulf War the U.S. was forced to go to foreign producers to meet the ODS requirements. The respondent strongly felt that the Government needs to find a domestic source of supply to meet the needs of the industrial base. Relating to this reliance of foreign producers, another respondent stated that if the civilian industry cannot meet this need, perhaps the DoD must maintain this need at one of their arsenals or ammunition plants (i.e., the dual-use of GOCOs).

The issue of market research also surfaced while discussing the CIB items that were best suited for dual-use. The interview respondent stated that the dual-use potential could be better served if DoD would ensure that the teams responsible for evaluating the requirements do a better job determining what is available in the civilian sector and how it can be modified to meet the Government's need. This interview respondent stated:

> The Government's mindset has previously been to optimize toward the mission needs. Now the focus is changing to optimizing the production potential to meet the mission needs at a reasonable cost.

It is perceived among defense contractors that the Government is not helping the U.S. industrial base by allowing foreign producers to compete with an already small number of domestic contractors for defense requirements. Table V in Chapter II showed that two of the nine chemical industrial base producers were foreign. There are no data available at one source to show what the percentage is at the subcomponent level. The contractor community perceives that DoD has not done their part to help U.S. businesses expand their markets overseas. The sentiment among several of the defense contractors interviewed is that if foreign Governments can promote their companies abroad, so should the U.S. One chemical industrial base producer stated, if the U.S. is not going to help them then they need to get out of the way. The U.S. Government restricts the products and technologies that commercial producers can export to certain countries.

The chemical industrial base producers generally state that it would not cost anything for the U.S. Government to promote the products they produce commercially overseas. These producers felt that because there was a greater chemical threat in some foreign countries an endorsement of their military and commercial products by the U.S. Government would help. This endorsement would permit the U.S. company to capture a foreign market share and sustain the CIB through this increase in foreign sales of their commercial products. The increased purchase of the U.S. producers commercial products abroad will provide a larger business base for the producer. This would all be **no cost** to the U.S. Government.

One respondent felt that the DoD, through establishing ARPA, revealed its support for dual-use technology initiatives. The DoD policy as stated previously, is to support dual-use technologies as opposed to military specific development efforts. The support of dual-use promotes a positive relationship with the commercial industry. The general interview population feels that the acceptance of dual-use as the cure-all poses a risk. The risk arises when the U.S. does not have the technological capability to support the chemical industrial base items needed for contingency. The defense contractors and some Government interview respondents felt that the any reliance on foreign producers is risky and has an impact on our readiness.

8. If dual-use technology were applied to the defensive chemical equipment in the Chemical Industrial Base, what are the disadvantages to the Government and Defense Contractors?

One respondent felt that a defense contractor that is solely reliant on DoD for their business base may consider dual-use detrimental to his viability as a defense contractor. The respondent stated that some contractors are happy and comfortable with their defense business and have no desire to gain a share of the commercial market. The respondent stated that he attained this perception from his years of experience working with contractors. The respondent further stated that because the contractor does not have a desire to they will not make an effort to do so and will lose their competitive status in the defense sector. The competitive status will be lost because they will not be able to lower their production cost commensurate with those producers that have adopted dual-use methods.

Another interview respondent felt that the previous efforts of awarding research and development contracts for proof of principle and system design have the potential to take away research and development efforts from private industry. The respondent felt this way because these contracts although they were Government efforts were awarded to private firms. The respondent stated that the Government is currently the only entity with the financial resources available to invest in high-risk technological areas. The private commercial industries cannot afford to take on such risks. The Government, through their investments in these high risk areas, are essentially "growing a capability" in that specific technological area.

One respondent stated that the Government must be extremely careful because the commercial availability of the systems formulations and deficiencies could be made known to potential enemies and terrorists. Another respondent stated that the availability of such technology to "rogue" nations may allow the enemy to develop countermeasures to the system's capabilities.

In some instances of dual-use technology, the cost may not be as low as expected. One respondent felt the small quantity production buys of chemical defensive items may not make dual-use as cost effective as it could be. This respondent felt the increased cost due to the smaller buys would not allow the full potential of the dual-use of technology to be recognized in the chemical industrial base. This can be countered by promoting the dual-use of the facility. The lowered cost from the dual-use of the facility and would trickle down eventually to lower the production cost.

The overwhelming majority of interview respondents indicated that the Government bureaucracy creates hassles for the contractor. One interview respondent stated that the commercial corporate staff is a bureaucracy in itself and is just as bad as the Government's. The Government can control this bureaucracy with effective contracts with quality control procedures for acceptance and payment liability. One respondent stated:

> The "true" defense contractors will now have to make a living in the real world. Right now there are many defense contractors that count on the Government contracts and reimbursements for storing equipment. It is their bread and butter. They do not even try to make it on their own. We

> never hear anyone complaining about these welfare recipients. A lot of them count on the Government as a paycheck and do not ever produce a quality product.

The nature of the cumbersome procurement process puts the Government at risk of companies refusing to do business with DoD because of this process. The Government needs to look at what is being made and what is needed to fill the gaps.

9. If dual-use technologies were applied to the defensive chemical equipment in the Chemical Industrial Base, what are the advantages to the Government and Defense Contractors?

Thirty-seven percent of the respondents felt that dual-use offers the CIB the potential for lower production costs to Government and industry. One respondent felt that the lowered production costs will leave more funding available to allow the contractor to employ more specialized engineering and support staff to support the base.

One respondent felt that the dual-use of technology would add stability to the chemical industrial base. The respondent felt that this would permit the contractors that support the base to retain defense viability. Thirty-seven percent of the respondents felt that the ability to ramp up rapidly during national emergencies would be improved and the startup time for dual-use would be cost effective due to:

- The start-up times for the Government and contractor would be minimal
- State-of-the-art technology for chemical equipment would always current
- There would be a production line running almost continuously

One respondent felt that dual-use offered the CIB an opportunity to justify plant and equipment for both Government and commercial use and gain the advantage of the lowered operating cost.

One respondent felt that the DoD business base has shrunk to a point where doing business with DoD is no longer affordable. The respondent felt that in order to gain affordability and maintain readiness, savings can be gained through the reuse or joint use of the facility.

Two respondents felt that dual-use offered the CIB the benefit of having more than one source to the sector. One respondent also felt that dual-use would allow the protection of domestic sources by permitting business to remain solvent.

Two respondents felt that dual-use offered stability to the CIB. In addition to stability, the respondents felt that dual-use offered an opportunity for the Government to broaden the CIB by attracting more contractors to do business with the Government. These respondents also felt that by attracting more producers the requirement for mobilization planning could be removed.

C. ANALYSIS

The dual-use technology concept in the CIB can provide benefits if planned and implemented properly. The research indicates that dual-use knowledge exists within the Government and the commercial sector. There is no clear guidance or rules concerning dual-use. The research also indicates that the restrictive regulatory guidelines that have plagued many new Government programs in the past may hinder dual-use.

1. Awareness of dual-use

The dual-use technology concept is relatively new to DoD. Since its introduction in 1989, it has become the newest "buzzword" in DoD. There is awareness of the concept of dual-use among the Government, defense contractors, and at least one person in academia. There is limited knowledge about dual-use within DoD. This means that each agency focuses on its piece of the issue and not on how this piece may have an impact on other agencies. The step toward standardization among the DoD agencies and services could help eliminate this "tunnel vision."

The problem within DoD is that not everyone is operating from a common definition. A common definition is important to enable all participants to work toward the common goal of sustaining the CIB.

In addition to common terminology, guidance on implementing dual-use is required. The DoD has tried to establish common dual-use terminology and preliminary guidance through the publication of its *Dual-Use Strategy* in February 1995. The DoD has an agency with responsibility for dual-use policy. The agency that published this strategy is the Office of the Undersecretary of Defense for Economic Security, Dual-Use Technology Policy. This office is the DoD focal point for dual-use technology policy. The Dual-use Strategy phamplet only begins to scratch the surface for providing guidance and terminology on dual-use. The strategy supports the reforms in acquisition by emphasizing how these reforms will help change the culture required on dual-use success. It also provides DoD an opportunity to make a tremendous impact for dual-use efforts by setting the precedence for innovation by establishing a culture that promotes dual-use efforts in major weapon system acquisitions.

2. Use of dual-use technology by DoD and other agencies.

There is awareness of ARPA and the role of this organization in dual-use efforts. Most of ARPA's dual-use efforts are high risk, high technology dual-use areas and there is little emphasis given to areas such as the CIB. As mentioned in Chapter II, these areas are just as important as the high pay off areas because the services and supplies provided by these producers are just as critical. The DoD should ensure that all sectors of the industrial base receive equal emphasis. Each sector of the industrial base is important in its own way and deserves monitoring

There has been limited use of dual-use technology. This has probably because of the lack of guidance on promoting dual-use initiatives. The GPS program discussed in Chapter II provided an example of the success of dual-use in a program but it also revealed the problems that will be encountered in implementing dual-use efforts in major system acquisitions. These problems are not beneficial to promoting dual-use.

The problems occur because on the one hand, DoD announced its preferences for dual-use efforts (i.e., COTS, NDI, and dual-producing) but when Program Managers (PMs) use these methods they are crucified when these efforts fail. There should be more incentive for innovation in DoD. The DoD has to establish a culture for promoting innovation. If DoD speaks of promoting innovation it must also support it. The DoD, through reforms in acquisition, has reemphasized its support for innovation but there have not been any dual-use efforts in DoD in major weapon system acquisitions since these reforms.

The DoD should also place more emphasis on dual-producing. The research reveals that successful implementation of dual-production in one agency provided lower production and facility maintenance cost. This would be extremely beneficial to small sectors of the industrial base like the CIB.

3. Application of dual-use to the CIB

The literature and interview findings all reveal that the dual-use of technology in the CIB is possible. Several areas in the CIB may benefit more from dual-use efforts than others. As stated in the above findings, the areas of detection, collective protection filtration and individual protection are best suited for dual-use efforts. Although this is true, dual-use of technology has not been applied extensively. This is primarily because there are still some hurdles to overcome to change the focus from defense-unique items and eliminate the stigma associated with chemical warfare production. This stigma is probably due to the lack of knowledge. History has shown that people fear what they know little about. The best solution for this would be for the CIB producers and the Army chemical focal point (CBDCOM) to join forces and initiate a positive promotion campaign within the commercial sector for the supplies and services manufactured for the Defense Department.

The CBDCOM currently has an organization responsible for integrating the technologies used throughout CBDCOM. The organization is responsible for establishing an interface with industry to market these technologies. There are initiatives within ARPA to help market these technologies. These initiatives are the TRP and SBIR programs. These programs are oriented toward small businesses that specialize in high risk technology areas.

The research revealed that, although the dual-use of technology offers a way to sustain the CIB, it cannot fix the problems that already exist in the base. The existent problems such as the lack of standardization, inability to attract and retain producers, and uneconomical quantity procurements cannot be fixed by dual-use. As mentioned in Chapter II, prior to Section 1101 of the NDAA for FY 1994, each service was permitted to do things its own. The redesignation of the lead service is important and will help facilitate standardization and eliminate the majority of the duplications.

4. Chemical defensive equipment production problems

The production of CDE is plagued by small uneconomic quantity procurements, duplication among the Services, small business base and the in ability to attract and retain producers. These problems exist because there are no peacetime requirements for CDE and the only procurements are to replace replenishment stocks or to produce new systems.

Perhaps the most important discovery of this research was the difficulty in attracting new and retaining current producers in the CIB. This is a problem that dual-use can help but cannot eliminate. Dual-use could offer new producers the opportunity to share their production costs between their commercial and military efforts. This shared cost would depend on the percentage share of the production allocated among the Government and the contractor's commercial customers. The retention of current producers may find some relief with the implementation of FASA. The relief will be provided by the preferences for commercial products, specifications and standards. This research revealed that one CIB producer departed the CIB and ceased production of defense products because of the Governments previous acquisition practices of awarding to the lowest cost producer. The research revealed that this producer expressed no interest in returning to defense production. This producer was a reliable, reasonable, and responsible producer.

The DoD chemical focal point should reestablish contact with this producer and encourage him to reconsider the business opportunities available to his company under the dual-use initiatives and acquisition reform.

5. Dual-use and special procedures

The dual-use of technology in the CIB may require some special procedures. The research reveals that special procedures would be necessary to determine if the strengths and weaknesses of the systems should be released. Although, there are mixed reviews on this issue, the best judgment would be to follow the old rule "better to be safe than sorry."

The special nature of the CIB dual-use technology could permit the use of these weapons against the American public in terrorist type incidents. The possibility of a terrorist incident poses a national security risk. The use of special procedures to limit access to the technology could probably decrease the risk. The downside to these special procedures is that they inherently reduce the flexibility required for successful dual-use implementation.

The use of special procedures may be useful for delineating the intellectual property and copyrights of the Government and the contractors involved in dual-use efforts.

The DoD in establishing guidance for dual-use efforts should consider special procedures and instructions on a case-by-case basis.

6. Chemical defensive equipment best suited for dual-use

There are some areas in the CIB that may benefit more from dual-use efforts than others. This research revealed three specific areas with the best dual-use potential. These areas are:

- Detection (chemical, biological and radiological)
- Collective protection filtration
- Individual protection (protective mask and clothing)

It is likely that these areas were most prevalent among the interview respondents because there is current commercial use of some of the items in use in FEMA. During the last five years FEMA has been actively involved in various catastrophic accidents and incidents throughout the nation.

In addition to FEMA, the Environmental Protection Agency (EPA) has caused increased public recognition of the hazards caused by radioactive radon. Radon is a naturally occurring radioactive contaminant and, because it is an alpha emitter, the continued exposure over time is cumulative and more dangerous with prolonged exposure. The EPA heightened awareness among the general public and promoted the desire of "John Q. Public" to purchase radioactive monitoring devices to determine what level of radon is in his or her home.

The recent incidents of terrorist activity in Japan involving military-grade chemical munitions against the general public has also promoted the desire by private citizens to obtain protective mask and clothing for their families. These areas offer more potential in the commercial market for dual-use efforts. Military chemical detectors with the capability to detect and identify chemical contaminants up to five kilometers away are very attractive in the commercial sector. As previously mentioned, the safety factor provided by a stand-off detector is also a very attractive feature.

The issue of foreign sources must be addressed with areas suited for dual-use. In some instances, there are items in the CIB that are produced solely by a foreign source. Specifically, the carbon used for the all protective filters is a foreign-based source. Dual-use could help to decrease and eventually eliminate this reliance on a foreign source. The DoD should test the commercial grade carbon for use in military filters. Additionally, DoD should pursue dual-use efforts to establish a domestic source for carbon.

7. Dual-use disadvantages

There are some disadvantages of dual-use in the chemical industrial base. These disadvantages primarily relate to the cost savings that will be generated. The Government historically has overrated cost savings. For example, initial Defense Department reports to the media on the cost savings estimated by the Base Realignment and Closure Commission (BRAC) were higher than actual savings. This may also be true for dual-use efforts. In an effort to minimize this, DoD should appoint one point of contact for conducting the cost estimates and cost effectiveness evaluations to retain consistency.

Another disadvantage may be that there may be some areas where there is limited or no dual-use potential. One such area is the decontamination area. The toxicity of DS-2, a military-grade decontaminating agent, limits its dual-use potential. It is more toxic and corrosive than the strongest commercial decontaminating agents. In this day and age, with the emphasis on environmental concerns, the commercial sector is producing decontaminating agents that neutralize the industrial chemicals and are friendly to the environment. DS-2 does not meet this criteria. The Government should evaluate replacing DS-2 with a decontaminating agent that meets the military decontamination requirements and is less toxic than DS-2.

The uneconomical quantity procurements and the low dollar value of the CIB contracts combined with the large start-up cost discourages commercial contractors from conducting business with the Government. The commercial contractor is looking for the bottom-line, profit. The above items do not provide a means for contractors to increase their bottom line. In fact, these items decrease the profit margin.

8. Dual-use advantages

There are several potential advantages available to the CIB from dual-use. These advantages were covered in the previous chapter. The research reveals that the majority of the interview respondents felt that the advantages of dual-use far outweighed the disadvantages.

One of the most important potential benefits from dual-use is the ability to attract new producers into the CIB. The opportunities for new producers would be the ability to split the start-up cost between the Government and commercial production efforts. This alone could substantially lower a product's production cost and increase the producer's profit margin.

The attraction of new producers to the CIB is important because it offers the availability of more than one producer for CDE. This is extremely crucial in national emergencies because if one producer is unable to rapidly attain his surge capacity, the availability of two or more producers increases the production capacity. This means that a production capability would be available almost continuously and may reduce the mobilization planning requirements.

Another important benefit provided by dual-use is the retention of current producers in the base. Retaining current producers stablizes the base with experienced and reliable producers. The retention of current producers also provides opportunities for these producers to gain access to the commercial market. The DoD should promote dual-use through the advantages and benefits it offers the producers because if the producers win the Government also wins.

D. SUMMARY

The research reveals that the dual-use technology concept is supported by all levels of the federal Government from the executive level down to the legislative level. The support is very strong among defense contractors due to the potential benefits for lower costs. The interview results show that the dual-use technology concept can be applied to the CIB. The "how" of its application is situation dependent based on technology. The research reveals that the dual-use technology concept applies not only to the technology but also to the use of the facility for dual-production of commercial and military equipment and supplies. The research also reveals that in an effort to achieve dual-production efforts, the Government is not interested in bartering with defense contractors to obtain production capability for CIB items.

The dual-use of technology offers the CIB the potential for lowering the costs of production and the end item cost in several areas. These areas are collective protection filtration, chemical, biological, and radiological detection, and individual protection. These areas were the most popular choices among the interview respondents for the items that would reap the most benefits from the dual-use concept.

The research reveals that the lack of standardization of similar items among the four Services has an impact on the uneconomic quantity procurements in the CIB. These procurements may have an impact on the benefits of dual-use.

Although dual-use has numerous benefits, there is a downside to dual-use as well. The system's strengths and weaknesses would be available to the general public as well as potential enemies. This availability poses a national security risk to the nations' defense. This would be an area that merits further evaluation to determine the risks to national security.

V. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

This thesis determined that dual-use technology can be applied to the chemical industrial base. This thesis further determined that with the application of dual-use, the chemical industrial base attains the benefits of sustaining the base and the producers, retaining proven producers, lowering the cost of production, and gaining dual-use of the production facilities. In this chapter the thesis research questions are answered and recommendations are made for areas further study. This thesis further determined that there is a strong support within the DoD for dual-use ventures.

B. CONCLUSIONS

The summarized answers to each research question presented in Chapter I are as follows. The answers to the subsidiary research questions will be presented first because they lay the foundation for answering the primary research question.

1. Subsidiary Research Questions

The subsidiary research questions for this thesis were as follows:

What is the CIB?

The CIB is one of the major sectors of the DIB. It is comprised of producers of the defensive chemical equipment and supplies required to support our armed forces if there is an offensive chemical attack.

What types of industries make up this CIB?

The CIB sector of DIB is comprised of approximately 40 defense contractors, domestic and foreign. The majority of the industries are small businesses that rely of the DoD for more than fifty percent of their business base. The CIB producers supply service and support to the following technology areas:

- Miniaturization technology in detection and electronic modules, microphones and audio equipment
- Printed circuit boards
- Lithium batteries
- Anti-gas cloth
- Textile manufacture of filter fabric-carbon spheres
- Polyethylene liner, hermetically sealed filter canisters
- Carbon impregnating

What makes the Chemical sector unique from other sectors of the DIB?

The Chemical sector of the DIB is unique from other sectors primarily due to the special and unique nature of the equipment produced in the base. There are perceptions that there are negative connotations associated with chemical warfare. These negative connotations act as an inhibitor to attract new producers into the base.

Another trait of the chemical sector is irregular, small quantity procurements. The CDE produced in the chemical sector is only required in the event of a chemical attack during contingency operations, which does not allow normal economic quantity procurements. In addition to the small, irregular procurements, the lack of standardization of CDE among the four Services also adds to this unique nature of the base. If all the Services pooled their requirements, then the quantities could become more economic and more regular.

What is dual-use technology and how does it relate to the CIB?

The dual-use of technology is technology that has commercial and military potential. It may be either NDI, COTS, or a combination of the two. The dual-use technology concept also applies to the facility where the technologies are produced. It relates to the CIB because it is a means for contractors that produce defensive chemical equipment to retain their viability in the base and gain a share of the commercial market. Dual-use provides a means for lowering the production cost of equipment.

Does the current situation of the Department of Defense budget and downsizing require the application of dual-use technology?

The DoD budget does not require the application of dual-use; however, the projections of further budget reductions require some action be taken to negate the possibility of not being able to support the CDE needs of the soldier. The dual-use of technology is a logical possibility to allow DoD to minimize cost, and to sustain the base and its producers.

The DoD focal point for dual-use of technology efforts within DoD, ARPA, has received extensive funding for dual-use efforts under the TRP and SBIR programs. The RDT&E budget for ARPA has doubled during a five-year period when the DoD budget was declining. The SBIR program specifically focuses on small business innovative efforts in designated critical technology areas.

What are the DoD's goals and objectives concerning dual-use technology

The goals and objectives of DoD concerning dual-use technology are to promote the dual-use of technology beneficial to the Defense Department. DoD strongly supports dual-use initiatives as indicated by the increased funding for ARPA's TRP. DoD also supports the dual-use of GOCO facilities through facility contracting.

How can dual-use technology be applied to the CIB?

Dual-use can be applied to the CIB at the component system level. The stand-off chemical detectors and hand-held chemical detectors have the technology that is easily adaptable for the commercial sector. The carbon used in particulate filters can also be used in the production of commercial grade filters to monitor toxic chemicals at industrial chemical facilities.

What are the disadvantages of dual-use technology to the CIB?

The availability of the technology to the general public exposes the strengths and weaknesses of the system to potential enemies. The additional costs incurred from indemnification under dual-use of GOCO facilities potentially offsets any cost savings realized from the dual-use of the technology.

What are the advantages of dual-use technology to the CIB?

Dual-use technology provides an opportunity to sustain the CIB and the producers in the base. It provides the opportunity to lower the costs of production and subsequently the cost of the item and an opportunity for GOCO facilities to be used for defense and commercial advances. This offers the potential to lower the cost of operating and maintaining the facility.

2. Primary Research Question

Finally, the primary thrust of this thesis was: **What are the benefits of using the concept of dual-use technology to sustain the CIB?**

The dual-use of technology can provide sustainment to the chemical industrial base and the producers only if there is a commercial need for the item. The sustainment of the base must also be support by DoD and defense contractors. The producers in the CIB will be able to maintain continuous operation of their production facilities. The dual-use of technology provides access. It provides the Government and defense contractors access to state-of-the-art technology at reduced cost. This access to high technology also provides an opportunity for the Government and the contractor to obtain equipment upgrades with technology at reduced cost.

The dual-use of technology provides defense contractors an opportunity to gain access to commercial markets, both domestic and foreign. The access to these markets does not promise success. The contractors must market their companies and products accordingly to gain and retain a share of these markets. The access to the foreign market will mean that the CIB producer may be required to modify his or her product or service to meet the unique requirements of the foreign market.

The availability of the CIB technology to all domestic and foreign sources provides the general public and the U.S. enemy the strengths and weaknesses of the technology of the weapon system, so this is a potential diadvantage.

The dual-use of technology offers the advantage to both the Government and the contractor to lower the cost of production and the end item. This lowered cost also affords the opportunity to buildup the production base quickly. With this lower cost, the contractor would be afforded the opportunity to attain a better engineering and support staff and the Government would be able to obtain the capability to extend the chemical industrial base surge capacity.

The dual-use of technology concept provides an avenue for the Government to reevaluate the need for mobilization planning. The continuous availability of the production capability negates the need for mobilization planning.

C. RECOMMENDATIONS FOR FURTHER STUDY

The below listed areas are recommended for further study:

Determine effectiveness of dual-use in sustaining the DIB and its sectors.

This research determined that dual-use of technology has the potential to be a means to allow sustainment of the CIB and its producers. Additional research should focus on the specific applications of dual-use to other sectors of the DTIB and how it has provided sustainment, lowered cost, and allowed defense contractors to capture a share of the commercial market.

Develop a pilot project to test dual-use application to the CIB and develop specific measures of effectiveness to determine if dual-use achieved success in sustaining the CIB.

There have been no direct applications of dual-use to the CIB. There have only been projects of its applicability and potential benefits. The areas identified in this research as best suited for dual-use should be used to develop the project.

Additional research should be done to evaluate the reasons defense contractors are leaving the defense industry and what impact the dual-use of technology might have.

Throughout this research, the perception among defense contractors was that the Government was not concerned with their success or failure as DTIB or CIB producers. This research revealed that this perception caused at least one proven and reliable producer to discontinue defense operations. A detailed analysis of the perceptions and problems among the small defense contractors should be conducted. This analysis should also evaluate what impact the dual-use of technology might have.

Establish a pilot project to test dual-producing in the CIB.

The dual-production efforts of one agency reveals that significant cost savings can be attained from this effort. The evaluation of this project should be conducted in one of the areas best suited for dual-use. The evaluation should also determine the cost effectiveness of the project for actual savings to DoD and the defense contractors.

APPENDIX A. INTERVIEW QUESTIONS

My name is Captain Gwendolyn O. Dingle. I am a student at the Naval Postgraduate School in Monterey, CA. I am conducting interviews for use as input to my Master's thesis. I would like to solicit your views on the dual-use of technology and whether this concept can be used to sustain the production of chemical defensive equipment within the Chemical Industrial Base.

Dual-use technology is the production of supplies and equipment by defense contractors on the same production line that is used to produce supplies and equipment for commercial customers. Current examples of the dual-use of technology are the 9-mm Beretta and the Global Positioning System. The objective of my thesis is to determine how dual-use can be used to sustain the chemical industrial base. That is why I am looking to people like you for comments and advice.

I would like to conduct telephone interviews with a representative of your organization during the week 24 April- 28 May 1995. The estimated time for conduct of the interview is approximately 30 minutes. To expedite the interviews, I have enclosed a copy of the questions to be asked during the interview for your review.

All information gathered for this thesis will be combined with other responses and this will assure the anonymity of each participant.

Thank you, for your input. If you have questions, please feel free to contact me at your convenience.

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1. **DEMOGRAPHICS**

Job Title:____

Location and Office Symbol: ______________________________

____

Series or Grade: ____

Years of Experience working dual-use technology issues: ____________

Years of Government experience:___________________________

Years in current position: __________________________________

2. Has your agency used dual-use technology?

3. Do you know of any other agency that has used dual-use technology?

4. Do you think the dual-use technology concept can be applied to defensive chemical equipment in the Chemical Industrial Base? Why?

5. What is wrong with the production of defensive chemical equipment in the Chemical Industrial Base that could be remedied by applying dual-use technology?

6. If dual-use technology is applied to the defensive chemical equipment in the Chemical Industrial Base should there be special procedures or instructions on how, when and where to use the concept to ensure that is applied effectively?

7. Of the chemical defensive equipment produced in the Chemical Industrial Base which lends itself more to the use of dual-use technology?

8. Is dual-use technology the solution for DoD to sustain small sectors of the Defense Industrial Base like the Chemical Industrial Base?

9. If dual-use technology were applied to the defensive chemical equipment in the Chemical Industrial Base, what are the disadvantages to the Government and Defense Contractors?

10. If dual-use technology were applied to the defensive chemical equipment in the Chemical Industrial Base, what are the advantages to the Government and Defense Contractors?

APPENDIX B. LIST OF INTERVIEWEES

Bachner, George, Senior Liaison Engineer Government Products, Mine Safety Appliances, Murraysville, Pennsylvania 15668, May 1995.

Branscomb, Lewis, M., Director, Science Technology and Public Policy in the Center for Science and International Affairs, John F. Kennedy School of Government, Harvard University, 79 JFK Street, Cambridge, Massachusetts 02138, April 1995.

Blische, John, Physical Scientist, U.S. Army Medical Research Institute for Chemical Defense, ATTN: MCMR-UV-RC, Edgewood Area, Aberdeen Proving Ground (APG), Edgewood, Maryland 21010, May 1995.

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Carrico, Jack, Industrial Specialist, HQ AMCCOM, ATTN: AMSMC-IRA, Rock Island, Illinois 61299-6000, April 1995.

Dacas, Kenneth, Programs Coordinator Commercial Division/Contract Administration, Donaldson Corporation, Mailstop 365, Minneapolis, Minnesota 55440, May 1995.

Fein, Saul, Director of Marketing, Intellitech, 2000 Brunswick Lane, Deland, Florida 32724, May 1995.

Fox, William, Process Manager for Industrial Base Assessment, CBDCOM, Edgewood Area, Aberdeen Proving Ground, Edgewood, Maryland 21010, May 1995.

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Thedford, Debra A., Major, Total Asset Visibility Task Force, 6301 Little River Turnpike, Suite 320, Alexandria, Virginia 22312, May 1995.

Thomas, Richard, Vice President, Engineering, Environmental Technologies Group, Inc., Baltimore, Maryland 21284, May 1995.

Windesheim, Bruce, Director Material, Alban Enterprises, Camp 9421 Brookmede Court, Ellicott City, Maryland, 21042, May 1995.

Vinyard, Mary, Industrial Specialist, Armament, Chemical, Ammunition and Logistics Agency (ACALA), Rock Island, Illinois 61299-6000, April 1995.

APPENDIX C. LIST OF ACRONYMS

AAR	After Action Report
ACALA	Armament, Chemical, Ammunition and Logistics Agency
ADPA	American Defense Preparedness Association
APG	Aberdeen Proving Ground
ARPA	Advanced Research Projects Agency
AMCCOM	U.S. Army Armament, Munitions and Chemical Command
BDO	Battle Dress Overgarment
BRAC	Base Realignment and Closure Commission
BUR	Bottom Up Review
CAA	Chemical Agent Alarm
CAM	Chemical Agent Monitor
CBD	Chemical Biological Defense
CBDCOM	U.S. Army Chemical and Biological Defense Command
CDE	Chemical Defensive Equipment
CIB	Chemical Industrial Base
CPE	Collective Protective Equipment
CSIS	Center for Strategic and International Studies
DA	Department of the Army
DARPA	Defense Advanced Research Projects Agency
DBMS	Database Management System
DCSOPS	Deputy Chief of Staff, Operations
DDR&E	Director of Defense Research and Engineering
DIB	Defense Industrial Base
DLA	Defense Logistics Agency
DoD	Department of Defense
DoE	Department of Energy
DPA	Defense Production Act
DSMC	Defense Systems Management College
DTIB	Defense Technology Industrial Base
ECP	Engineering Change Proposal
EMD	Engineering and Manufacturing Development
EPA	Environmental Protection Agency
ERDEC	Edgewood Research Development Engineering Center

FEMA	Federal Emergency Management Agency
FY	Fiscal Year
GAO	General Accounting Office
GFE	Government Furnished Equipment
GOCO	Government Owned Contractor Operated
GS	General Service
GPS	Global Positioning System
HASC	House Armed Services Committee
HQ	Headquarters
IOC	Industrial Operations Command
JLC	Joint Logistic Commander
LMI	Logistics Management Institute
MCPE	Modular Collective Protection Equipment
MOA	Memorandum of Agreement
MOE	Measure of Effectiveness
MOP	Measure of Performance
MRC	Major Regional Contingency
MRI	Magnetic Resonance Imaging
NASA	National Aeronautical Space Administration
NDAA	National Defense Authorization Act
NDI	Non Developmental Item
NBC	Nuclear, Biological and Chemical
NBCRS	NBC Reconnaissance System
NSS	National Security Strategy
ODS	Operation Desert Shield/Storm
OPA	Other Procurement Army
ORTA	Office of Research and Technology Applications
ORD	Operational Requirements Document
O&S	Operations and Support
OTA	Office of Technology Assessment
OOTW	Operations Other Than War
PMO	Project (Product) Management Office
R&D	Research and Development
RDT&E	Research, Development, Test and Evaluation
RSCAAL	Remote Sensing Chemical Agent Alarm
SCPE	Simplified Collective Protection Equipment

SICPS	Standardized Integrated Command Post System
S&T	Science and Technology
SWA	Southwest Asia
TRP	Technology Reinvestment Project
USACMLS	U. S. Army Chemical School

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